THE JOURNAL OF PROSTHETIC DENTISTRY

Vol. 1 May, 1951 No. 3

EDITORIALS

WELCOME

IT IS with genuine pleasure that the Editorial Council and the Editor announce the affiliation of the American Academy of Restorative Dentistry with THE JOURNAL OF PROSTHETIC DENTISTRY. THE JOURNAL OF PROSTHETIC DENTISTRY is now the official publication of the American Academy of Restorative Dentistry as well as of the American Denture Society, the Pacific Coast Society of Prosthodontists, and the Academy of Denture Prosthetics.

The agreement between the Editorial Council and the American Academy of Restorative Dentistry is another indication of the sincere sense of cooperation in the field of dentistry for the good of all. The willingness of the American Academy of Restorative Dentistry to share its talent and knowledge with all of dentistry is typical of the profession today.

The American Academy of Restorative Dentistry (see p. 209) is a highly respected scientific dental organization. It considers, in its sessions, all kinds of prosthetic restorations. The articles which it will furnish to the JOURNAL on fixed prosthesis will round out the coverage of problems of dental prosthesis.

Dr. George A. Coleman will serve as the Associate Editor to represent the American Academy of Restorative Dentistry. The Editor is very happy to welcome him to his staff. He will collect papers presented before the Academy and screen them for publication in the JOURNAL. We are sure that this material will add much to the value of the JOURNAL to its readers.

—Carl O. Boucher.

REACTION TO THE JOURNAL

THE enthusiastic response to THE JOURNAL OF PROSTHETIC DENTISTRY has nearly overwhelmed the Editor. It has made us very happy and has stimulated us to even greater efforts to make THE JOURNAL OF PROSTHETIC DENTISTRY the medium for the exchange of ideas it should be. The credit for the JOURNAL should not go alone to the Editor, but should go as well to the Associate Editors, Emil Bollwerk, Roland Fisher, and Raymond Nagle who so ably assisted us in gathering the material for the JOURNAL. The efforts of the entire Editorial

Council and the Contributing Editors should be recognized for their part in the successful debut of the JOURNAL. None of it could have happened if all of these had not worked so hard to make it so. The Editor shares the plaudits with all of those who helped.

The Editor wishes to thank the staff of The C. V. Mosby Company for their marvelous cooperation and assistance. We are proud to have the opportunity to know and work with these people. They went out of their way to help us get started in a task which was entirely new to us.

COMMENTS ABOUT THE JOURNAL

It is impossible to print all of the nice things that have been written to the Editor, and he is too modest to include some of them. These are quotations from some of the congratulatory letters: "Heartiest congratulations on first issue Journal Prosthetic Dentistry. American Denture Society is proud of your accomplishment and thrilled at sight of a dream come true," Harold L. Harris. "My Journal has just arrived. Please accept my heartiest congratulations. Your honest, tireless effort has produced a Journal that surpasses anything I have ever seen. We shall all share the pride of accomplishment, but to you must go the credit for this most splendid piece of work.", Roland Fisher. "The successful future of the 'Journal' is a foregone conclusion.", Thomas E. J. Shanahan. "Yesterday, our mailman delivered my first copy of the new Journal of Prosthetic Dentistry. I have neglected doing other things to peruse its pages. Congratulations to you and your colleagues on the fine production of these splendid articles. Every good wish for the continued success of you and of this new baby.", Robert R. Gillis. "Congratulations on the Journal of Prosthetic Dentistry. It is much needed, most timely, and will contribute greatly to the progress of Prosthetic service.", M. M. House. "I want to tell you again what a splendid piece of work the Journal is. I have derived a great deal of pleasure in reading the excellent editorial and the many fine articles. I particularly enjoyed Bliss's article.", Jack Werner. "The first number of the Journal of Prosthetic Dentistry came in the mail this morning. It is superb. You have every reason to be proud of this splendid first number. Congratulations to you and your entire staff.", Edward J. Ryan. "Got the first issue of the new Journal the other day, as did many others in this vicinity, and have heard nothing but the highest praise in its behalf. May I congratulate you on the fine job you are doing, for I think I realize what a stupendous task it is to get such a Journal together.", Irving R. Hardy. "First, I want to congratulate you on the fine job of editing the Journal. Our Council certainly made a very fine choice in electing you. This first issue assures the success of the Journal, and, although many men entered into the making of the Journal, I want you to know that I believe the success of this Journal is through the untiring efforts you have put forth. The reward is in the product—a Journal we can all be proud of.", W. Les Warburton. "I wish to compliment you on your Prosthetic Journal. The

appearance is very good and the contents well chosen as to material and variety.", Felix A. French. "New Journal just arrived and it's a honey. Congratulations!", Victor H. Sears. "Heartiest congratulations to the Editor of a wonderful new Journal. It is really 'tops' and a most valuable contribution to the field of dental journalism. The articles appearing are well chosen, the make-up is most pleasing — legible print, clear illustrations and the general lay-out is most complete. The thanks of the profession and particularly of your fellow prosthodontists go to you for this splendid work.", Charles H. Jamieson. "The Journal came about an hour ago, and I've had a hard time to lay it down. I think it's great.", L. Thomas Asche. "Our hats are off to you and will you please take a bow! As Editor of the new 'Journal', you are to be congratulated. It is a fine piece of work you are doing, and I certainly am enjoying this first number and am looking forward to the ones to follow.", Earle S. Smith. "Congratulations on the new Journal of Prosthetic Dentistry! This first issue looks very interesting and appears to be what those interested in that field of dentistry have needed and wanted for a long time. Am looking forward to future issues.", Fred T. Baumgartner. "This promises to be a magnificient contribution to prosthetic practice.", E. Ernest Rose. "The first issue of The Journal of Prosthetic Dentistry arrived this morning. I thought I would be able to go through the book hurriedly as I do many of the other magazines that come across my desk. This issue is so packed with useful information that I don't expect that I'll be able to set it aside for several evenings. You deserve the support of everybody interested in prosthetic dentistry for the outstanding job you've done with this first issue. If the next few issues are anything like this first, selling subscriptions for the book will be an easy matter.", J. J. Nevin.

The Editor and his associates say *THANKS.*

—Carl O. Boucher

EVALUATION

THE JOURNAL OF PROSTHETIC DENTISTRY came into existence to provide a medium for the expression of current thinking on the subject of dental prosthesis. Therefore, it will be the policy of the JOURNAL to present to its readers the worthwhile articles which are submitted. To be worthwhile, an article should present something new, something different, or something stimulating to constructive thought. The only provisions are that the material be of value to the dental profession, and be in a correctly prepared form which is understandable.

The Editor believes that every ethical dentist should have the right to express his views regardless of the Editor's evaluation of the material. In other words, your Editor believes in freedom of speech in scientific writings.

Freedom of speech imposes a responsibility on those who talk or write. Each author should consider the effect of his writings upon the readers of his article. Freedom of speech also imposes the responsibility of evaluation upon each reader.

If the reader has all sides of each problem clearly explained, he can and should analyze the merits of each possible solution. He can then arrive at his own conclusions.

Research is done either to find out something, or to prove something. In the first instance, the experiment is set up to find out what data can be obtained under given circumstances. In the second instance, the experiment is set up to prove that an idea is right or is wrong. There are examples of both types of research in this issue of THE JOURNAL OF PROSTHETIC DENTISTRY. The reader must evaluate articles in this JOURNAL.

No doubt many articles which will appear on the pages of the JOURNAL will contain ideas with which the reader will not agree. This is a healthy condition, because it stimulates thought. These thoughts of the readers can become articles for future issues of the JOURNAL if the readers will only put them on paper. The Editor will be happy to have these articles to consider for publication. There can be honest differences of opinion and differences of interpretation of facts. These differences can be discussed without resorting to name calling and inuendo. Let us strive for intellectual honesty in ourselves, and a respect for this same quality in others. Let us use our freedom of speech in the science and art of Dentistry. Let us say what we have to say in a way that will help others, or will stimulate others to tell wherein we are wrong. With this free interchange of ideas will come further progress in the field of dental prosthesis.

—Carl O. Boucher

THE AMERICAN ACADEMY OF RESTORATIVE DENTISTRY

GEORGE A. COLEMAN, D.D.S.

Philadelphia, Pa.

N the late twenties a group of visionary men of our profession, which included Herman Maves, Paul Edmond, Theodore Maves, Herman Chayes, Ralph Morrison, and several others, discussed and finally organized The American Academy of Restorative Dentistry. They had seen the necessity of forming a society where they could convene and evaluate the problems of reconstruction as presented by different members of the profession. Their desires are very strongly expressed in Article II, Section I of the Constitution which reads as follows:

> The objects of the Academy shall be: to promote the art and science of dentistry, especially as it applies to the use of natural teeth in restoring and maintaining a healthy functioning mouth; to disseminate among its members and to the dental profession the knowledge thus gained through research work; to co-operate with all similar organizations in matters of mutual interest; to encourage and maintain the highest professional standard among its members and the dental profession; to promote mutual understanding among its members; to hold meetings and assemblages of its members for all of the purposes mentioned.

SECTION II:

> The Academy is not organized for profit or for business purposes and no part of the net earnings of the Academy shall inure to the benefit of any person, and all of the net earnings, if any, of the Academy shall be devoted exclusively to the uses and purposes of the Academy as defined in the foregoing section.

These principles as laid down by the founders have been followed religiously over the intervening years. Among the early members were: William Squires, Nye Goodman, A. Klaffenbalt, Carl W. Hoffer, the Mortonson brothers, Ed Hart, Harry G. Morton, Daniel H. Grubb, James A. Graham, Heyward Street, Marshal Weaver, and others of equal importance in dentistry.

Twenty-one annual meetings have been held at which many interesting papers and clinics have been presented, much of the value of which has been lost due to the lack of proper publication opportunities. Many papers which should have been catalogued and used for reference in the libraries of the members have not become available.

The editors of the *Journal of the American Dental Association* have been very generous in publishing papers of the Academy whenever possible, and to them the Academy is very grateful, but their facilities have been limited and they could not do more.

The new JOURNAL OF PROSTHETIC DENTISTRY closes a void that has been present in Dental Literature for a long time. It offers the opportunity for better distribution of knowledge to the membership at large of the profession, which has been presented at numerous meetings, which heretofore could not be published.

The American Academy of Restorative Dentistry welcomes the opportunity of co-sponsoring the JOURNAL OF PROSTHETIC DENTISTRY and it looks forward to many fruitful publication years from which the sponsors, the publishers, and the profession will gain great benefits.

Success is based on vision and hard work. The new JOURNAL has these qualities for future accomplishment.

235 So. 15th STREET,
PHILADELPHIA, PA.

OFFICERS OF THE AMERICAN ACADEMY OF RESTORATIVE DENTISTRY

Chairman of the Council ..... O. B. Coomer, Louisville, Ky.

President ..... Paul K. Hill, Pasadena, Calif.

President-Elect ..... Kenneth A. Bignell, Chicago, Ill.

Secretary-Treasurer ..... Allison K. James, Beverly Hills, Calif.

GUEST EDITORIAL

THINK

THINKING on prosthetic dentistry has developed greatly over the years, even though we have been bombarded with the viewpoint that one way and only one way would accomplish a successful end result. True scientific progress can never be made in this way.

We were all interested to find that the first issue of THE JOURNAL OF PROSTHETIC DENTISTRY gave varied opinions and more than one way to accomplish a successful end result. I refer particularly to the papers of Dr. Irving Hardy and Dr. Clyde Schuyler. We who know these men realize that they have been very successful in the field of dentistry. Not only are these men well grounded in the fundamental principles of prosthetic dentistry, but they have developed new techniques and have unselfishly shared them with all of us. We know that the JOURNAL will create a desire on the part of more men to study and through study develop new and perhaps better techniques. Students of prosthetic dentistry are anxious for more information. Every man receiving the JOURNAL should feel that he has the responsibility of sharing his views as a means of improving and developing techniques of prosthetic dentistry. Do not let others do all of your thinking.

If we are to accelerate progress in the study of prosthetic dentistry, two methods of procedure are recommended:

1. We should participate in study groups and test our findings.

2. We should communicate our results through lectures and writings.

The Indianapolis Dental Research Group has found that group study develops our thinking and improves our techniques. There is no question but that organized study clubs develop better dental operators. Since 1935 we have attempted to cover the field of prosthetics in our group. At first we did only the practical work; and we found our progress very slow. The reason for this was that we did not know fundamental principles. Therefore, we began to study in detail the anatomy of the head and neck. Is it not true that a good mechanic knows the structure and operation of every part of the automobile? We found frequently we were working on the head before thoroughly understanding the anatomic structures and their functions. Many prosthetic men have written papers in recent years that stress the importance of outline form and stress-bearing areas. I refer you to many of the recent papers by Dr. Theodore A. Bodine, Dr. Carl Boucher, and Dr. Roland Fisher. These men taught techniques and were well known for their fine lectures on techniques. We are glad to find today that they are stressing anatomic outline form.

Some papers have been written which state that the Gothic Arch tracing is not an accurate method for establishing centric. In our study group we think that the Gothic Arch tracing should be used. It gives a check on the tactile sense registration. We think an adaptable instrument gives us the best result. We think metal bases should be used in some cases. We think that plastic teeth are more comfortable; however, in many cases they show excessive wear. We think that we get the best results with anatomic cusp teeth. Now, these are some of our findings. What do you think?

THE JOURNAL OF PROSTHETIC DENTISTRY will have over 900 pages a year This is equivalent to a large textbook. We can make it a significant contribution to prosthetic dentistry. We now have the JOURNAL. In order to keep it the Editor needs papers. The success of our JOURNAL depends on an unselfish effort on our part to share our thinking with others.

—John W. Geller

PRINCIPLES OF FULL DENTURE IMPRESSION MAKING AND THEIR APPLICATION IN PRACTICE

ARTHUR L. ROBERTS, D.D.S.

Aurora, Ill.

STUDIES of basic principles are apt to be criticized as "rehashes" unless some spectacular technique is advocated, because all of us participate in the very human trait of seeking the one, elusive, magic solution to our problems. Any new and startling method is apt to receive more attention than would a thoughtful analysis of the principles involved, although reason should tell us that the problem should be approached with the word "why" rather than "how." Nevertheless, I propose to consider some of the "why's" of full denture impression making, together with some factors in denture construction which seem to be closely related to the actual impression.

The impression is the second step in full denture construction. Examination, including prognosis, is the first step. In the examination, all aspects of the case are studied: the anatomic, the physiologic, the mechanical, and the psychologic. From information thus obtained, procedure is planned. The advisability of conservative surgery to improve the foundation may be considered, such as the reduction of bilateral bulbous tuberosities which produce opposing undercuts, the removal of pendulous soft tissue, smoothing of sharp, bony ridges, or freeing closely attached frena. All of these things complicate the prosthetic problem. To be considered, also, is the possible necessity of corrective nutritional therapy. Many denture patients (those who must lose their remaining natural teeth, and those who are in need of new artificial dentures) are improperly nourished. Dietary insufficiency is reflected in the oral mucosa with the result that this tissue may be handicapped in meeting the unusual demands which the wearing of artificial bases will impose upon it. Attention to this phase of the problem with a view to insuring a balanced ration, with inclusion of the vitamins and minerals, will pay big dividends, not only in the oral health of the patient but in his physical and mental state as well. Artificial dentures must rest upon tissues which were never intended, by nature, for such use. Dentures place a load upon scar bone and scar connective tissue. Too often, these scarred remains are horribly deformed. That is where preparatory surgery can be a help. They may be unhealthy due to poor nutrition. That is where a corrective diet comes in. The dentist who undertakes to supply prosthetic appliances, in these cases, without considering the preparatory steps has two strikes on him when he begins. He is making a demanding procedure unnecessarily difficult for both his patient and himself.

Before starting impressions, a mental picture of the denture should be developed in the mind of the operator. This picture should be not only of the

Read before the Academy of Denture Prosthetics, Milwaukee, Wis., May, 1950.
Read before the American Denture Society, Atlantic City, N. J., October, 1950.
Received for publication Dec. 27, 1950.

peripheral form of the appliance as it is developed in the impression but should also include the proposed external form. A close relationship exists between the requirements for an adequate impression and the contemplated external form.

The three specifications for an adequate full denture impression are:

1. The form of the denture foundation, that is, the oral tissues which must resist the stresses of occlusion, should be recorded without distortion.

2. The outline of the basal seat, that is, the entire area to be covered by the denture, should be recorded as it is determined by functional movements of border tissues.

3. Reliefs and dams should be placed, at the operator's discretion, in strategic areas.

Stated simply, the impression is the result of the way the foundation tissues form it, plus what the border tissues do to the edges, plus what the operator does to it. Truly, denture impressions are made, not taken.

The first specification, "that the denture foundation be recorded without distortion," has received much emphasis recently. Like many basic truths, it has been rediscovered and reheralded as a new idea. The profession is indebted, nevertheless, to the exponents of the "mucostatic" idea. These enthusiasts have demonstrated graphically the physical laws which support this first specification. It seems wrong, however, for them to contend that these "mucostatic" principles are in conflict with all other accepted rules of impression making and cannot be incorporated into a more inclusive technique. That tissue distortion by pressure will cause denture dislodgement when the distorted tissue tries to regain its unstrained form is quite self-evident.

Retention is the quality in a denture which resists displacement by forces applied in a direction away from the base. Stability is the quality which resists displacement by forces applied toward the base. Both of these qualities are enhanced by intimate adaptation and maximal tissue coverage.

The phenomena of adhesion, cohesion, atmospheric pressure, gravity, and, more recently, interfacial surface tension have been shown to be factors which aid in providing retention. All of these apply to the relationship of the tissues to the inside surface of the denture. Frequently overlooked is another important aid to retention, one which greatly determines impression outline; this is the development of a denture, the external form of which is in harmony with the musculature of the cheeks and tongue. *The outside of the denture should fit the patient, too.* The impression outline should be planned to provide this external form.

Close adaptation to the basal seat contributes to retention by making use of the phenomenon of adhesion, which results from the attraction of molecules of the fluid film for the inside of the denture on one side and for the tissue on the other. Together with cohesion of the fluid film molecules for each other,

adhesion produces a relatively lower pressure under the denture base than atmospheric pressure. In engineering, pressures less than atmospheric are referred to as "suction." We are not too far wrong in using the term "suction" in connection with the retention of artificial dentures.

Close adaptation to the basal seat also contributes to stability. Tissues which are recorded in the impression without distortion and then are contained by the denture base will resist vertical crushing loads. The degree of the effective resistance is in direct ratio to the amount of containment. Total containment is obviously impossible.

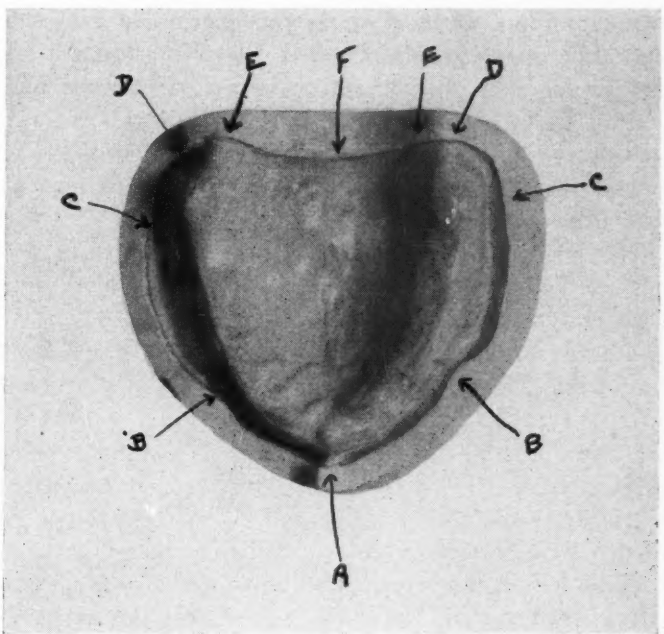


Fig. 1.—Upper cast to show peripheral outline and form. Note the thickening in the region of the buccal vestibules.

The term "functional impression" is used usually to describe one which is molded under biting stress, the object being to produce a denture which fits best under this load. Actually, dentures are in occlusion only a very small part of the time. Most of the time, they are lightly in contact with the mucosa, which obligingly tolerates them as physiologic intruders. The upper denture is suspended from the tissues, not pressed upon them. Alveolar atrophy may result from either a positive or negative force. Therefore, artificial dentures should be just snug enough to stay in place. Among patients who have worn dentures a long time, the most nearly normal tissues are found in those whose appliances have just a comfortable fit. Dentures should fit the supporting tissues at rest — not under stress. Impressions should be made with this in mind.

The second specification is: "The outline of the basal seat should be recorded as it is determined by functional movement of border tissues."

Fig. 1 shows the peripheral outline on a cast for a full upper denture. The labial and buccal border outline should not be visualized as a line but rather as a surface, usually rounded, which lightly contacts the peripheral tissues of the basal seat, and the contiguous labial or buccal mucosa as well. It is part of the inside of the denture and also part of its external form. It has a variable thickness. Examination of many finished dentures would seem to show that determination of the border thickness is not generally given the attention it deserves.

In the labial part (*A* to *B*), the thickness depends upon the volume desired for the esthetic support of the upper lip. Distal to the buccal frena (*B* to *C*), the border is generally much thicker, depending upon the horizontal width of the buccal vestibule. Thickening in this region is desirable because it makes possible the development of an inwardly inclining plane from the border toward the molar teeth. Pressure by the muscles of the cheek on this inclined plane aids in holding the denture up in place. This is one illustration of the way a correct external form and the impression are related. There are several other such areas, as I shall demonstrate.

As the tuberosity is rounded, the border thickness (*C* to *D*) is reduced to avoid impingement on the tissues overlying the mandibular ramus when the lower jaw is protruded or moved laterally.

Medial to the distobuccal turn, the edge is located over the hamular notches (*E*), which are readily located by palpation with a blunt instrument or the fingernail.

From this point on, the distal border presents a unique situation. Elsewhere, the relationship of edge to base is that of a rounded surface comfortably contacting both the mucosa of the basal seat and the adjacent soft tissue, peripheral seal being obtained by a sort of enveloping action of these tissues, not by tight contact. The distal border, however, must be stopped on a continuing surface, and the problem is further complicated by the fact that this surface is a slightly movable one. Effective seal here demands pressure contact.

Many operators prefer to scribe the distal boundary of the upper denture on the cast. It would seem that accuracy would be better served if it were determined as a part of the impression technique because effectiveness of the outline, and its associated dam, could then be tested in the mouth. Too wide or too deep a dam can cause loss of retention. These factors are more readily adjustable in the impression than on the cast.

The distal edge of the horizontal plate of the palatine bone is the limit of the denture-supporting area but the basal seat is extended distal to it for the following physiologic reason: the pressure of a dam, if placed on tissue supported by bone, would result in loss of fit as bone is readily changed by pressure. The edge, therefore, is extended to rest upon tissues overlying the palatal aponeurosis, a muscular structure which is not susceptible to pressure atrophy.

The junction of the hard palate and the soft palate can be seen by noting the difference in hue between the more vascular soft palatal tissues and that of

those over the hard palate. This junction can also be observed by noting the outline of the displacement which occurs in the soft palate when, with the patient's nostrils held closed, he is requested to attempt to force air through the nose. In this test, observation of the angle made by the palatal tissues to their anterior attachment aids in placing the denture edge. The angular range is great. As it becomes relatively more acute, placement of the edge is made increasingly more critical.

Generally speaking, a line from hamular notch to a point just distal to the fovea palatina (*F*) provides a guide for the distal border outline. This area will be considered later in discussing the third specification, reliefs and dams.

Measurement of the comparative perimeters of upper and lower dentures shows that the lower border outline is usually one-half again as long as the upper.

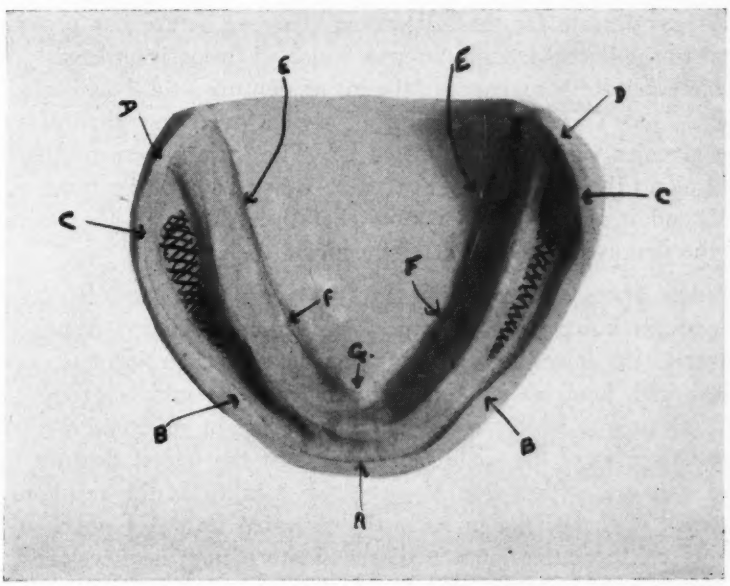


Fig. 2. — Lower cast to show the peripheral outline and form.

On the other hand, measurement of the supporting areas of these same dentures shows the lower to have about one-third of the area of the upper. This interesting comparison brings out the fact that the ratio of border area to total area in the lower is much greater than in the upper. Add to this the fact that the entire lower denture border is influenced by movable tissue, whereas less than one-half the upper denture border is subject to this hazard, and it is easy to understand why so much study has been focused upon the lower, particularly its peripheral form.

Fig. 2 shows a lower cast. The labial outline (*A* to *B*) follows the line of flexure produced by functional movement of the lower lip. Its thickness is dependent upon the volume of support to the lip demanded by esthetics. In the

region of the buccal frenum (*B*), a very important region is encountered, not because of the frenum, in itself, but because it marks the proximity, buccally, of a center of great muscular activity. The triangularis, zygomaticus, and caninus muscles converge here (in the cheek), to form a strong but movable base from which the orbicularis oris and buccinator muscles may operate as antagonists. Impingement upon the denture base is avoided here not only by careful placement of the border above the level of vertical tissue movement, but also by thinning the flange and border, as much as possible, to prevent lateral pressure which would tend to squeeze the denture from its seat. As the muscle actions in this area are studied, it becomes clear why lower dentures which are too wide at this point do not stay in place. A simple notch in the denture border to accommodate the frenum is insufficient. The whole outer surface of the denture in this area must be made narrow.

As if to compensate for this disturbing element, nature has provided immediately distal to the buccal frenum an area which, if properly utilized, provides the most valuable supporting surface for the lower denture—the buccal shelf (shaded area in Fig. 2). This shelf consists of tissue overlying cortical mandibular bone. The alveolar ridge lies medial to it. The lower fibers of the buccinator are attached along the external oblique ridge which bounds the outer edge of the buccal shelf, and it is important to note that these fibers of the buccinator run parallel to the denture edge, not at right angles to it.

The middle fibers of the buccinator (those which act to keep food between the teeth) may act independently of the lower group of fibers. When the middle group contracts, the lower group may remain relaxed to form a pocket which may be filled with food without interference from the middle group. It is into this pocket (*B* to *C*), which varies greatly in size in different individuals, and also on opposite sides of the same individual, that the buccal denture flange may be extended with the expectation of increased stability as the result of favorable external form. With the flange correctly extended into this pouch, a favorable inclined plane on the outer surface of the denture may be developed on which the cheek muscles may act to hold the denture in place. The stabilizing value of such external inclined planes, correctly related to the musculature, cannot be overemphasized.

The buccal flange is limited distally by the masseter muscle which passes upward, just outside of the buccinator, in this area (*C* to *D*). Between the two muscles lies a fatty pad, the suctorial pad, and the distobuccal turn of the base is placed under this pad.

The distal border includes the entire outline of the retromolar pad, if possible, then turns downward and medially to enter the retromylohyoid space. The form of this pouchlike space (*D* to *E*) is variable, depending upon the throat form. As much of its area as possible should be included in the basal seat. By so doing, stability will be gained by the provision of a flange surface on which the sides of the heavy, relatively immobile base of the tongue may rest. Horizontal pressures against this flange by the mass of the tongue will tend to seat

the lower denture, provided the angle of the flange is downward and inward. Here, again, is an area where a favorably inclined plane on the polished surface of the denture can be utilized to help keep the denture in place.

The flange, in the retromylohyoid area, is placed in the area of functional equilibrium between the mylohyoid and superior constrictor muscles on the one side, and the tongue on the other. It does not rest upon bone-supported tissue but inclines medially away from the bone. The mylohyoid muscle runs downward, as well as medially, from its ridge attachment and is not a displacing factor, within limits, if the medial inclination of the flange is correct.

This inward flare (away from the bone) applies also to the lingual flange in the molar region (E to F). Flange length is limited at the level where functional movement of the floor of the mouth beyond normal needs would raise the denture from its seat.

Proceeding forward, the flange is shortened, and the edge brought closer to the ridge over the sublingual gland where the floor of the mouth rises and falls with the activity of the muscles lying beneath the gland.

Anteriorly, the border outline (F to G) is molded to accommodate the range of movement of the genioglossus muscle and the lingual frenum. The thickness of the edge in this region will be given consideration later in describing reliefs and dams.

We come now to the third specification: "Reliefs and dams are placed in strategic areas at the discretion of the dentist." It is necessary to relieve parts of the impression surface which may bear heavily upon hard areas when the dentures are used in chewing. Other areas may require easing to avoid pressures over vessels or nerves.

Relief over the median hard area of the upper jaw is made to avoid teetering of the denture when the ridge tissues become displaced during chewing or become resorbed. The amount of relief is governed not only by the hardness and extent of the area of the torus itself but also by the relative firmness of the ridges. Too much relief over the median area of the upper denture is to be avoided. Relief should be limited to the actual need because the palatal surface, in its entirety, is an important stress-resisting surface and, as such, is part of the denture foundation. Relief by scraping the impression should be kept to a minimum. Further relief may be made in the finished case, if necessary, if the palate part of the denture is formed a little thicker over this area when waxing up. Subsequent relief, if necessary, may then be made without risks of perforating the palate. When proper relief is obtained, the desired thickness of the palate part may then be completed.

The rugae zone and the incisal alveolar ridges, both upper and lower, may also require easing a little. This can best be done on the finished case after locating the areas which require it by the use of a very soft disclosing wax while the dentures are in use.

Further modification of the impression, at the operator's discretion, is the addition of dams in strategic areas. The most universal one is the posterior

palatal dam. The thickness of this dam, which extends across the distal upper denture edge from hamular notch to hamular notch, is governed by the resilience of the tissue on which it rests. The object of the dam is to maintain tissue contact when an anterior horizontal shift of the denture is produced by the use of anterior teeth for incision. Another reason for its use is to compensate for dimensional changes in the curing process. The use of anterior teeth for incision, in artificial dentures, should be discouraged by placing the incisal edges out of contact in all occluding positions. If this were done and curing shrinkages could be controlled, there would be little need for the posterior palatal dam in its present form.

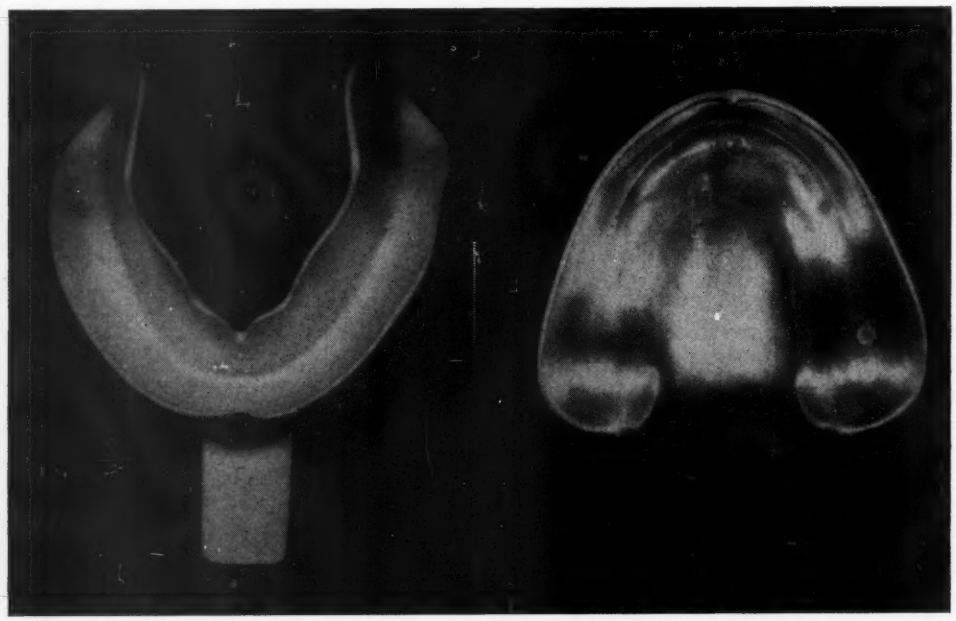


Fig. 3. — Stock metal trays in which preliminary impressions are developed.

Another dam, based on a different principle, may be effectively added in the anterior lingual area of the lower denture in those cases where the frenum offers little resistance. Effectiveness of any dam depends upon the amount of tissue coverage and the degree of tissue displacement. By employing the first factor only (that of coverage, not displacement) by extending the anterior lingual border backward somewhat over the floor of the mouth, but not downward, retention may be gained. Thickening of the edge in this area, where possible, increases the peripheral contact in a critical region. The resulting distally sloping surface tends to guide the tip of the tongue to lie above and upon it, which is a most desirable tongue position. A very practical advantage of this dam, also, is that the added mass strengthens the denture in a region particularly susceptible to breakage.

I have attempted to show why the denture foundation should be recorded without distortion, why the border is formed with varying thickness and placed as it is, and why reliefs and dams are added. With an understanding and acceptance of these basic requirements as they apply to each denture case, and a knowledge of the physical properties of impression materials, it should not be difficult to devise a suitable impression technique. Certainly, no single stereotyped technique is universally applicable, but procedure should be based upon an evaluation of all aspects of the case at hand. With this explanation, I should like to describe a technique which illustrates an application of the basic principles, is both simple and accurate, and yet lends itself readily to modification. In this technique, both impressions are developed as relines of primary bases but the details of procedure in the upper and lower cases are quite dissimilar.

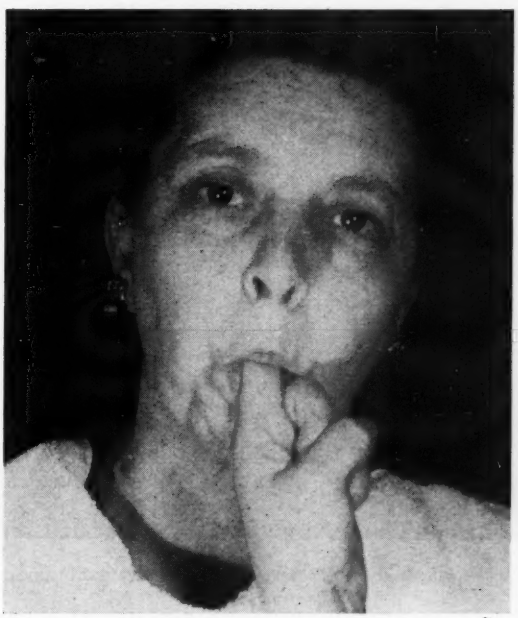


Fig. 4. — Suction trim of the upper preliminary impression.

The first step is the selection of a suitable upper and lower stock metal tray in which to develop the primary impressions. These trays (Fig. 3) are quite rigid but sufficiently malleable to allow of minor adjustments with a tray bender. Their polished surface, if slightly lubricated, will allow removal of dental compound in one piece if that becomes desirable. Both trays have very shallow flanges. The upper tray has no handle whatever. The lower tray has a very short, off-set handle. A most important feature of the design of the lower tray is the upward curvature of the distal ends so that an undistorted imprint of the distal part of the lower ridge, including the pad, may be obtained. This area is particularly susceptible to distortion. The posterior lingual flange inclines medially toward the tongue to lead compound into the retromylohyoid space.

Both upper and lower trays are selected and adapted with the idea of covering the entire basal seat with compound without allowing the tray edges to press upon it. This is important because the object of the primary impression is to work out the denture outline with reasonable accuracy.

The primary upper impression is made as follows: Low-heat compound, workable at 120° F., is placed in the upper metal tray and gently pressed to place until it is seen that the vestibules are well filled and a slight excess is escaping distally. With the tray and compound in place, the patient is asked to purse the lips and suck the dentist's index finger as it lightly supports the tray (Fig. 4.).

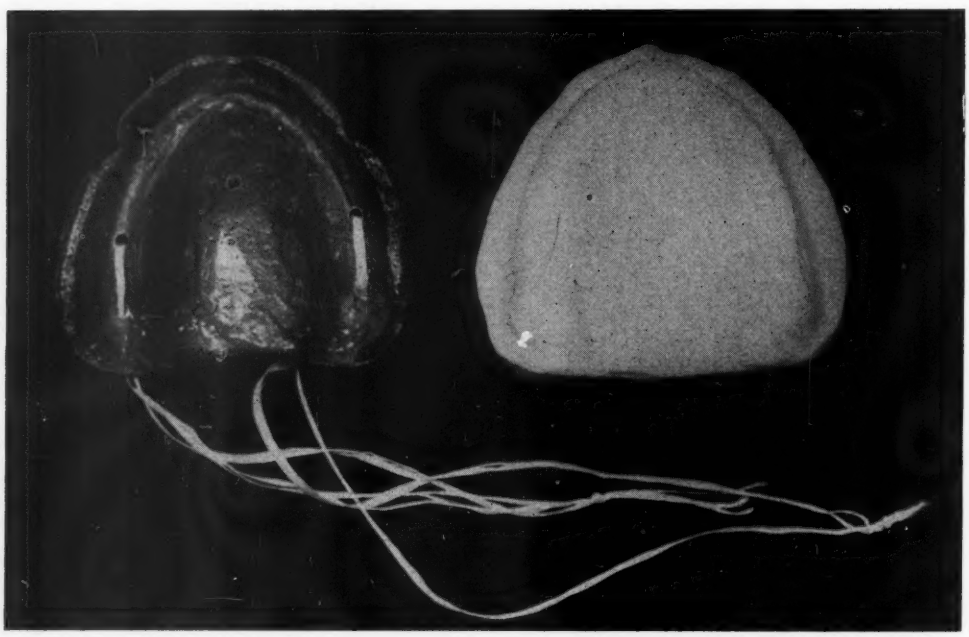


Fig. 5. — Oversized preliminary cast and individual upper tray.

Frequently, the border outline of the upper may be secured in this one simple operation. However, corrections may be made by torch trimming, if necessary. Lateral movements of the lower jaw will displace compound in the region of the tuberosities to mark possible interference with the mandibular ramus. At no point should there be evidence of displacement of border tissues by the metal tray.

Distally, the primary impression is knife-trimmed to a line connecting the hamular notch areas and passing slightly behind the fovea palatina. If these structures are not readily seen in the impression, a slight addition of softened compound and reinsertion will bring them out clearly.

The entire tissue surface of this primary compound impression is now scraped to a depth of two millimeters. A cast is made with quick-setting plaster of this scraped impression. This cast will thus be 2 mm. oversize. On this over-

sized cast, a tray is adapted, using double thickness shellac baseplate material or one of the self-curing resins. Two pieces of tape are threaded through holes one-half inch apart on each side of the tray to assist in removing the finished impression (Fig. 5). One or more escape holes are drilled in the median palatal area. These escape holes are very important. When a plastic mass, such as dental plaster, impression paste, wax, or compound, is pressed into contact with a surface, maximum pressure exists in that area which is furthest from the point of escape. By boring escape holes in the vault portion of the tray, pressure over the central area is prevented.

The upper impression is made with dental plaster. A smooth mix is obtained by mechanical spatulation. About a teaspoonful of this creamy plaster mix is placed in the vault of the mouth with a spatula. Then the tray carrying the plaster mix is gently pressed to place. When it is seen that the vestibule is well filled on both sides and a slight excess is squeezing out distally, the patient is again asked to suck the index finger supporting the tray, then draw the lips backward as in a grin, then remain quiet with the mouth half open.

Fig. 6.—Cross section of finished upper impression, showing an even thickness of plaster in the tray.

The resulting imprint should copy exactly the denture area without distortion. Border tissues should have registered their functional vertical outline, and the peripheral thickness should have been determined by contact with the muscles of the lips and cheeks. Any penetration of the tray through the plaster indicates tissue distortion and calls for another attempt. The upper impression is not a plaster wash; it is a plaster impression. A thin but even thickness of plaster should cover the inner surface of the tray (Fig. 6).

A posterior palatal dam is made by adding a thick mix of resinous cement across the distal border of the impression and seating it firmly back in the mouth. After it has set, this dam can now be tested for effectiveness. One which is too thick or too wide may defeat the purpose entirely, as will be evidenced by a lack of retention. In such a case, the dam should be scraped off and another attempt made. Fig. 7 shows completed upper impression.

The lower impression is made by relining an individual acrylic tray with one or more layers of resinous cement. The first step is the selection and adaptation of a stock metal tray, the design of which has been described. Softened, low-heat compound is gently carried to place in this tray. The patient is requested to open as widely as possible and extrude the tongue as far as possible. When the compound is hard, this impression is removed and obvious excess compound is knife-trimmed from it to allow more convenient reinsertion into the mouth. The peripheral form is now developed by areas, using the alcohol torch.

Fig. 7. — Completed upper impression.

The principles governing impression outline are followed. Manual manipulation of cheeks and lips by the operator is usually necessary to aid in forming the buccal and labial border limits. The lingual border is torch-trimmed by extrusive and lateral tongue movements. The outline is then perfected with a small amount of knife trimming, if necessary. Undercuts are removed but the surface in its entirety is not scraped as it was in the upper tray. Plaster is used to make a primary cast and a tray constructed, using one of the activated, self-curing resins. This tray has just a little stub of a handle in the incisal region. The lower tray is not oversize, only the undercuts are removed. The reason it is not made oversize is that we want to fit it in the mouth to see that it includes the entire denture area without being displaced by border attachments. If it were oversize, this could not be done.

Several escape holes are bored in this tray (Fig. 8). The reason for these holes is not quite the same as for those in the upper impression. Sticky, resinous cement is used as a liner in the lower and it will be placed on relatively dry mucosa. After the tray is seated, the fingers are removed from the mouth, and the tray actually floats free. If tissue impingement by the edges of the tray occurs so

that it is displaced upward, the tissues would be "sucked" upward unless escape holes were present. This type of tissue distortion is as injurious as one caused by a positive pressure. If escape holes are present in the tray, air will be sucked into them from the outside and an obvious defect will appear in the impression which may then be corrected.

Fig. 8. — Individual lower tray.

Fig. 9.—The finished lower impression is made by holding the tray very gently in place with instruments. No downward pressure is used.

The floor of the mouth, under the tongue, is lightly packed with gauze to remove excess moisture, and the patient's lips are lubricated with a pleasant-smelling oily cream. Resinous cement, mixed to the consistency of heavy cream, is placed in the acrylic tray. The gauze is quickly removed, and the tray seated evenly over the ridges. The patient is asked to half open the mouth, and bring the tongue forward until the tip lies lightly on the lower lip. The fingers are removed from the mouth and the impression material allowed to harden.

Fig. 10. — Completed lower impression.

It may be necessary to hold the tray very lightly in place with two short instruments, for patients with very poor ridges or for patients who are unable to cooperate well. These instruments are used only to steady the tray. No downward pressure of any consequence is used. By the use of instruments instead of fingers for this operation, the tongue position is not interfered with nor the labial tissues distorted (Fig. 9).

The first cement lining usually shows some areas where the tray has cut through, indicating tissue distortion by the tray, or areas where air has been sucked back through the escape holes. The areas where the tray shows through are relieved with a laboratory bur. All undercuts are again removed, and peripheral excess cut away. The first lining may be thought of as part of the trimming and fitting of the tray.

The escape holes are now opened up again and the tray is ready for a second resinous cement lining. That part of the first layer which is still in place will act to guide the tray to a better seat. If a tiny speck of Prussian blue dye is added to the second mix of impression cement, it is easier to determine whether coverage is even. If it is not covered evenly, the previous layer color will show through.

As many layers of resinous cement may be used as necessary to obtain an adequate impression, but a satisfactory result is usually obtainable by the use of two or three layers. Each time a layer is added, it is essential that peripheral excess be removed, all undercuts be eliminated, and the escape holes be reopened.

A very small amount of resinous cement is now added to the anterior lingual flange. None of it is allowed to get into the inside of the impression. The impression is then reseated in the mouth. Care must be used in placing this dam to produce only a distal extension, within functional limits, not a downward one (Fig. 10).

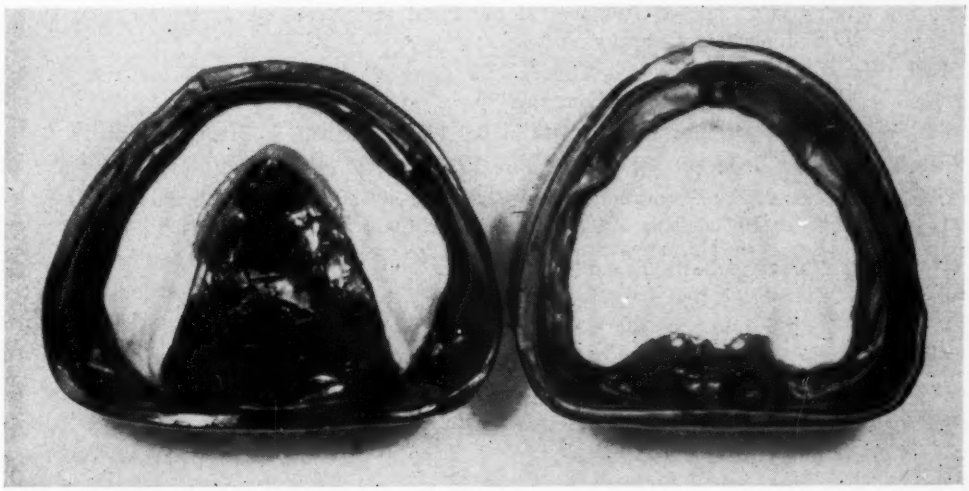


Fig. 11. — Completed upper and lower impressions, carefully boxed, to preserve outline and thickness of peripheries.

A satisfactory lower impression made by this method will be stable when tested in the mouth by pressing upon it at various points and from various angles. It will exhibit retention by contact and will not be displaced by movements of the tongue or lips within functional ranges. It will not show the tightness of fit which characterizes impressions made by methods which displace tissue. Such tightness is not desirable because it is always transient and causes tissue change.

The two impressions are now carefully boxed (Fig. 11) to preserve both the outline and the thickness of the borders, and stone casts are poured. Boxing should not be done in a hurried or careless manner.

The making of impressions for full dentures is an important step in denture construction. Good impressions contribute to retention, stability, and comfort of the finished appliances. They are the foundations on which we build our dentures and, as such, merit our best efforts.

REFERENCES

Boucher, Carl O.: Complete Denture Impressions Based Upon the Anatomy of the Mouth, J.A.D.A. **31**:1174-1181, 1944.

Boucher, Carl O.: Impressions for Complete Dentures, J.A.D.A. **30**:14-25, 1943.

Harris, Harold L.: An Upper and Lower Full Denture Impression Technique, North-West Den. **25**:135-147, 1946.

Wright, Walter H. A Method of Securing Correct Impressions, J.A.D.A. **27**:1584-1590, 1940.

Addison, Paul I.: Mucostatic Impressions, J.A.D.A. **31**:941-946, 1944.

DeVan, M. M.: Basic Principles in Impression Making, New York D. J. **14**:489-497, 1948.

Pryor, Walter J.: An Evaluation of Several Full Denture Impression Technics, J.A.D.A. **37**:159-167, 1948.

Shapiro, Harry H.: Applied Anatomy of the Head and Neck, ed. 2, Philadelphia, 1947 J. B. Lippincott Company.

Sears, Victor H.: Principles and Technics for Complete Denture Construction, St. Louis, 1949, The C. V. Mosby Company.

Neil, Ewell: Full Denture Practice, Nashville, 1932, Marshall & Bruce Company.

Fish, E. Wilfred: Principles of Full Denture Prosthesis, ed. 4, London, 1948, Staples Press.

Trapozzano, Vincent R.: Complete Dentures. Published in Lippincott's Handbook of Dental Practice, Philadelphia, 1948, J. B. Lippincott Company.

Aurora National Bank Building
Aurora, Ill.

THE EFFECT OF SURFACE CONTACT IN THE RETENTION OF A DENTURE*

E. W. SKINNER, PH.D.,** AND PAUL CHUNG, B.D.S., D.D.S., M.S.D.***

Chicago, Ill.

AT LEAST three physical phenomena have been mentioned as factors in the retention of a denture: atmospheric pressure,[1,2,5,6,7] adhesion,[1,2,3,4,5,7,8,9] and surface tension.[5,9,10,11] The work of Stanitz[9] is especially valuable in that it is proved by mathematical analysis that the effect of surface tension is secondary to the effect of atmospheric pressure. Snyder et al.[12] attempted to prove the effect of atmospheric pressure on the retention of dentures by measuring the force required to dislodge dentures in the mouths of patients placed in reduced pressure chambers. Their experiments apparently proved that the lower atmospheric pressures reduced the retention of the dentures.

Although the phenomena involved may appear to be concerned only with physical principles such as surface tension, atmospheric pressure, and adhesion, undoubtedly physiologic effects in function also contribute vitally to the retention of the denture. In order to eliminate any physiologic effects, and to study only the role of the physical phenomena in denture retention, Ostlund studied the retention of denture baseplates on a model constructed with a resin elastomer.[13] Ostlund found that the surface tension of the film between the denture and the model affected the retention markedly; the greater the surface tension, the greater was the retention. Also, he found that the thinner the film, the greater was the retention. Ostlund further demonstrated that small perforations in the denture along the ridge portion failed to affect the retention, but any perforations in the palate area produced a marked decrease in the retention of the denture.

PROCEDURE

The present research is a continuation of the work of Ostlund, to include the effect of post dam, peripheral seal, and relief areas on the retention of the denture.

An aluminum model of an upper edentulous mouth with all undercuts removed, was overlaid with a synthetic elastomer resin (Dicor-D) to simulate the soft tissues of the mouth (Fig. 1). The model was duplicated in dental stone, and a denture baseplate of clear acrylic resin (Densene 33) was constructed on the stone model, using a special injection—dry heat tenchnique. As shown in Fig. 2, wire loops were cured in the resin, to which hooks could be attached in testing the retention of the denture baseplate. One loop was attached to the anterior ridge area, and one each was attached in the right and left posterior areas.

The equipment employed for the determination of the retention is shown in Fig. 3. A laboratory balance was adapted for use in applying the force for testing

Received for publication, March 20, 1951.

*Abstract of a thesis presented by Paul Chung in partial fulfillment of the requirements of the Graduate School, Northwestern University for the degree of Master of Science in Dentistry.

**Professor of Physics, Northwestern University Dental School.

***Instructor in Prosthetic Dentistry, Northwestern University Dental School.

the retention. The master model (Fig. 1) was fastened in a horizontal position, as can be seen at the left in Fig. 3. The denture base was then secured to one arm of the balance by means of three hooks. The system was then counterbalanced with the metal container fastened to the other arm of the balance. The denture base was then thoroughly soaked with distilled water, as well as the surface of the master model. The denture baseplate was seated on the master model under a force of 3,000 grams, applied for five seconds. Water was then allowed to run into the container until the denture base plate was pulled from the master model. The weight of the water collected was assumed to be a measure of the retention of the denture baseplate. Every result presented is the average of five trials. The probable error, of the measurements as estimated from the average deviations is $\pm$ 4 grams.

Fig. 1.—Master model consisting of an aluminum model of an upper jaw without undercuts, overlaid with an elastomer resin to represent the soft tissue.

BEARING SURFACE OF THE DENTURE BASEPLATE

Two denture baseplates were constructed with complete and accurate contact with the master model, with no post dam, peripheral seal, or relief area. Two denture baseplates were also constructed with relief areas in the regions of the anterior and posterior palatine foramina and the central hard palate area. The relief areas in the regions of the anterior and posterior palatine foramina were 1 mm. in depth, and discoid in form, about 1.5 mm. in diameter. The central relief area was approximately 1.5 mm. in depth.

All attempts to produce denture baseplates with post dam and peripheral seal were failures, owing to the fact that the retention obtained was neither uniform nor sufficient to insure reliable data. It was evident that the elastomer resin possessed neither the flexibility nor the resiliency of the soft tissues it was supposed to imitate. As a result, the stone model could not be scraped with sufficient accuracy to produce a post dam, or peripheral seal of sufficient uniformity to impress the resin on the master model in a uniform manner.

The post dam and peripheral seal were produced by adding black wax to the denture baseplates prepared for the other tests (complete contact, and with relief areas) and forming the wax on the master model itself against the denture baseplate. The thermoplastic properties of the black wax were, of course, a source of error in any determinations of retention as previously described. However, before the test, the master model and wax-impregnated denture baseplates were immersed in ice water, and ice water was used as the intermediary film. It is believed, therefore, that the results obtained are at least indicative.

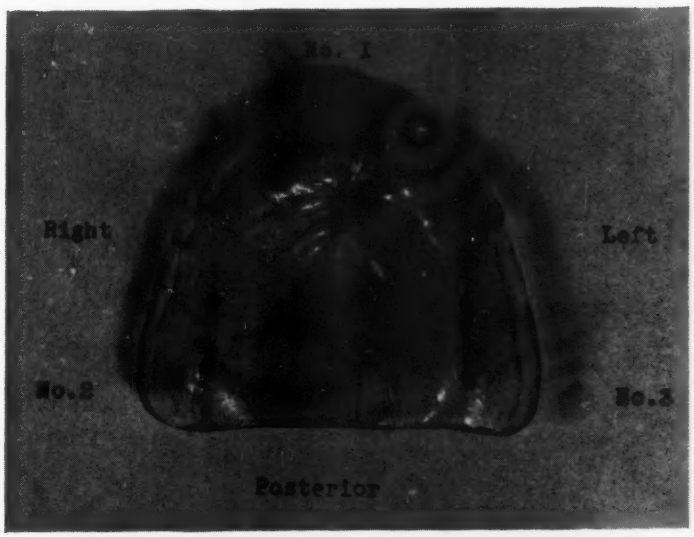


Fig. 2.—Baseplate with wire loops.

RETENTION OF ACRYLIC DENTURE BASEPLATES

All of the denture baseplates as described were tested for retention. The results are presented in Table I.

It is evident from Table I that the use of relief areas definitely reduces the retention of the denture. The reasons for this are probably twofold: (1) the denture

TABLE I. RETENTION OF AN ACRYLIC DENTURE BASEPLATE

TYPE OF SURFACE CONTACT	RETENTION (GM.)
Complete contact	192
With relief areas present	159
With post dam	219
With peripheral seal	232
With post dam and peripheral seal	247
With post dam, peripheral seal and relief areas	201

baseplates containing relief areas could not be seated on the master model without a few air bubbles appearing in the relief areas. The presence of this air undoubtedly reduced the retention due to atmospheric pressure. (2) The increase in the thickness of the liquid film in the relief areas also was influential in reducing the retention of the baseplate.[9]

The use of either the post dam or the peripheral seal increased the retention, and when both were employed at the same time, an additional increase occurred. However, when the relief areas were inserted in the denture baseplate in addition, the effects of the post dam and the peripheral seal were very nearly obliterated.

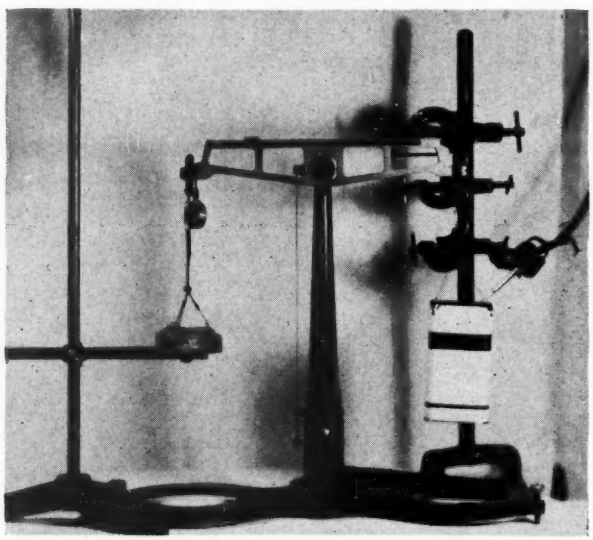


Fig. 3.—Apparatus employed for the testing of the retention of denture bases.

RETENTION UNDER UNEQUAL FORCE

In this test, each of the hooks (Fig. 3) was disengaged in turn, and the retention of the denture baseplates was determined. For example, if the right posterior hook was disengaged, the force would be applied along the left ridge, with the left posterior hook and the anterior hook fastened to the respective loops in the denture baseplate. Similarly, the effect of a force applied to the right ridge could be determined by releasing the left posterior hook. If the anterior hook was disengaged, the force was obviously applied across the posterior of the denture.

When the retentions of the denture baseplate are determined under these conditions, presumably the results are indicative of the action of the masticatory forces during function in dislodging the denture. The point of application and the direction of the masticatory forces will, of course, be opposite to the similar properties of the experimental forces. The results of these tests are presented in Table II.

It is evident from Table II that, in general, the retention of the denture baseplate was less across the posterior than along the ridges. Furthermore, the use of the peripheral seal was equally as effective in increasing the retention in this area

as was the use of the post dam. However, when both the post dam and the peripheral seal were used, the retention was increased in all directions.

As might have been expected, the peripheral seal was more effective in increasing the lateral retention, than was the post dam. The use of relief areas reduced the retention in all cases.

The retention along the right ridge was always less than the retention along the left ridge. The reason for this difference is apparently the presence of two buccal frena on the right side, and one buccal frenum on the left side of the master model (Fig. 1). Apparently, the notchlike reliefs for the frena in the buccal flanges of the denture baseplate produce a sufficient discontinuity in the meniscus of the liquid film to reduce the retention.

EFFECT OF PERFORATIONS

The work of Ostlund[13] in regard to the effect of small perforations in the denture baseplate was extended to include the effect of holes in the flange areas, as well as the palate areas. Since the perforations were approximately 1 mm. in diameter, it is assumed that the action of the perforation is to reduce the retention by decreasing the effectiveness of the atmospheric pressure as a retentive factor, rather than to reduce the action of adhesion and surface tension. Undoubtedly, the adhesion of the denture was also reduced somewhat as the holes became very numerous, but the general effect should be related to air pressure.

TABLE II. RETENTION UNDER UNEQUAL FORCE

SURFACE CONTACT	RETENTION		
	FORCE APPLIED:		
	POSTERIOR (GM.)	LEFT RIDGE (GM.)	RIGHT RIDGE (GM.)
Complete contact	129	141	133
With relief areas	114	126	118
With post dam	143	154	142
With peripheral seal	142	182	172
With post dam and peripheral seal	176	198	180
With post dam, peripheral seal, and relief areas	152	172	161

The holes were scattered at random over the denture baseplate in a number of combinations, but the result was always the same: Any holes placed in the ridge area at its contour of maximum curvature did not affect the retention, but if the perforations were placed in the flange areas or the palate areas the retention was reduced. The amount of the reduction was not necessarily a function of the number of holes placed in any given area, however.

A typical, routine record of such a test is presented in Table III. It is evident from the data that the ridge area of a denture base exerts little influence on the retention, on the basis of the assumptions previously stated.

TABLE III. EFFECT OF PERFORATIONS ON THE RETENTION OF A DENTURE BASEPLATE

NUMBER AND LOCATION OF PERFORATIONS			RETENTION (GM.)
FLANGE	PALATE	RIDGE	
0	0	0	188
1	0	0	159
2	0	0	156
2	1	0	156
2	2	0	156
4	2	0	154
4	4	0	152
4	8	0	152
9	9	0	136
9	9	2	135
9	9	9	135

TABLE IV. EFFECT OF STORAGE IN WATER ON RETENTION

TIME (DAYS)	RETENTION			
	COMPLETE CONTACT		WITH RELIEF AREAS	
	I (GM.)	II (GM.)	I (GM.)	II (GM.)
0	188	198	158	160
8	190	206	157	165
16	200	212	158	170
31	210	220	166	171
56	210	219		

EFFECT OF STORAGE IN WATER

When the denture baseplates were not being used for purposes of experiment, they were stored in water at room temperature, with the master model. During the period of the experiment, retention of the various specimens was measured at frequent intervals. The retentions so obtained are presented in Table IV for four of the denture baseplates.

A tendency can be noted for an increase in retention of the baseplates with an increase in time. Possibly, either the master model or the denture baseplate, or both, changed in dimension during the period of observation. Since the master model had been immersed in water for several weeks before the baseplates were constructed, presumably an equilibrium may have been established so far as the water sorption of the elastomer resin was concerned. On this basis, one is led to suspect that a warpage of the denture base may have taken place, similar to that described in another publication.[14]

SUMMARY AND CONCLUSIONS

The retention of acrylic denture baseplates to a model of an upper edentulous arch without undercuts has been measured. The surface of the model was overlaid with a synthetic elastomer resin to simulate the soft tissues; distilled water was employed as the medium between the denture base and the surface of the master model. The retention was tested on denture baseplates under (a) direct contact, (b) with post dam, (c) with peripheral seal, (d) with relief areas, (e) with post dam and peripheral seal, and (f) with post dam, peripheral seal, and relief areas.

The following facts and conclusions have been demonstrated by the data obtained:

1. The use of relief areas resulted in a decrease in the retention of the denture regardless of all other factors which may have tended to increase the retention.
2. The use of the post dam and peripheral seal, either singly or together, resulted in an increase in the retention of the denture.
3. The retention of the denture was less along the posterior border than along either the right or left ridge.
4. The peripheral seal was equal in effectiveness to the post dam in increasing the retention as measured across the posterior of the denture baseplate.
5. The peripheral seal was more effective in increasing the lateral retention, than was the post dam.
6. The buccal frena tended to reduce the retention of the denture.
7. The ridge area at the contour of maximum curvature apparently contributed nothing to the retention of the denture.
8. Evidence was presented for the fact that the acrylic denture baseplates may have warped during the time of experimentation.

REFERENCES

1. Richardson, J.: A Practical Treatise of Mechanical Dentistry, ed. 4, Philadelphia, 1886, P. Blakiston Son & Co., pp. 444-452.
2. Wilson, G. H.: A Manual of Dental Prosthetics, ed. 4, Philadelphia, 1920, Lea & Febiger, pp. 318-323.
3. Greve, K.: Luftdrusk und Adhasion bei der Befestigung des Zahnersatzes, Deutche Zahn Wechnschr. **30:** 25-28, 1927.
4. Fry, W. K.: Retention of Complete Dentures, Brit. Dent. J. **44:** 97-99, 1923.
5. Fish, E. W.: An Analysis of the Stabilizing Factors in Full Denture Construction, Brit. Dent. J. **52:** 562, 1931.
6. Tuller, C. S.: A Discussion of Some of the Basic Principles in Taking Impressions, Ill. Dent. J. **7:** 213, 1938.
7. Turner, C. R.: The American Textbook of Prosthetic Dentistry, ed. 7, Philadelphia, 1942, Lea & Febiger, pp. 266-273.
8. Schlosser, R. O.: Complete Denture Prothesis, ed. 2, Philadelphia, Reprinted, 1948, W. B. Saunders Co., pp. 57-58, 136.
9. Stanitz, J. I.: An Analysis of the Part Played by the Fluid Film in Denture Retention. J.A.D.A. **37:** 168-172, 1948.
10. Le Docte, J.: Theorie Physique de la Retention des Appareils Prosthetiques du Haut. La Rev. Stomat. **29:** 1076-1083, 1927.
11. Page, H. S.: Mucostatics, a Principle, not a Technique, pp. 22-23 (Copyright by the Author, 1946).
12. Snyder, F. C., Kimball, H. D., Bunch W. B., and Beaton, J. H.: Effect of Reduced Atmospheric Pressure upon Retention of Dentures, J.A.D.A. **32:** 445-450, 1945.
13. Ostlund, Stig. S. G.: Some Physical Principles in the Retention of Dentures, Northw. Univer. Bull. **49:** 11-19, 1948.
14. Skinner, E. W.: A Critical Analysis of Acrylic Resins Used for Denture Construction, Ill. Dent. J. **13:** 437, 1944.

THE TORUS PALATINUS AND ITS MANAGEMENT IN FULL DENTURE CONSTRUCTION

JOSEPH S. LANDA, D.D.S.*

New York, N. Y.

THE torus palatinus may be defined as a protuberance, or bony elevation, situated most often in the middle of the maxillary vault. It springs either from the intermaxillary (median palatine) suture or from the junction of the intermaxillary with the palatomaxillary (transverse) suture. Some writers on the subject define it as a form of exostosis; others feel that hyperostosis would be a more applicable descriptive term for this bony elevation, since it really presents a form of bone hypertrophy.

On the basis of its clinical manifestations, I am inclined to the view that it might be more appropriate to consider it as just another bony protuberance in the human anatomy (occipital protuberance, frontal protuberance, maxillary tuberosity, etc.) except that it is subject to greater anatomic variations with regard to its size, shape, and form. The prosthetic man's interest in this anatomic structure lies in its clinical implications in the retention of full upper dentures.

Not infrequently the success or failure of the upper denture is conditioned upon the proper management of the torus palatinus. The latter varies in size, shape, and form in different individuals. It may be so small as to be imperceptible to visual examination, but discernible to careful digital examination. The torus may be long and narrow, short and wide, and may consist of one large bony protuberance (attaining the size of half a walnut and more) or of several small ones fused together and assuming the shape of a mushroom. In most cases the base of the torus is wide and it tapers upward. Occasionally, however, we find tori that are narrow at the base and wider above, pedunculated, so to say, with undercuts of greater or lesser severity. This type of torus may lend itself, in exceptionally rare instances, to surgical removal, facilitating thereby the construction of the full upper denture. In all other instances surgery of the torus is a difficult and painful procedure, and of no material benefit to the patient. By having a clear understanding of the fundamental principles that underlie retention of full dentures, the operator will be in a position to decide why, when, where, and how a torus palatinus should be relieved. More than that, it is also essential that the operator understands the extent to which the dentures will settle, and the rate of this process. That is why a careful examination of the alveolar ridges, the palatal vault, and their mucosal covering is essential before we can arrive at any deci-

Received for publication Feb. 28, 1951.

*Clinical Professor of Prosthetic Dentistry, New York University, College of Dentistry.

sion with regard to management of the torus palatinus. The alveolar ridges and the palatal vault together make up the upper basal seat—the area against which the denture base is fitted. The palatal vault constitutes the *retentive area* of the denture; the ridges are the *supporting areas,* and the zygomatic process on either side are the stabilizing areas.

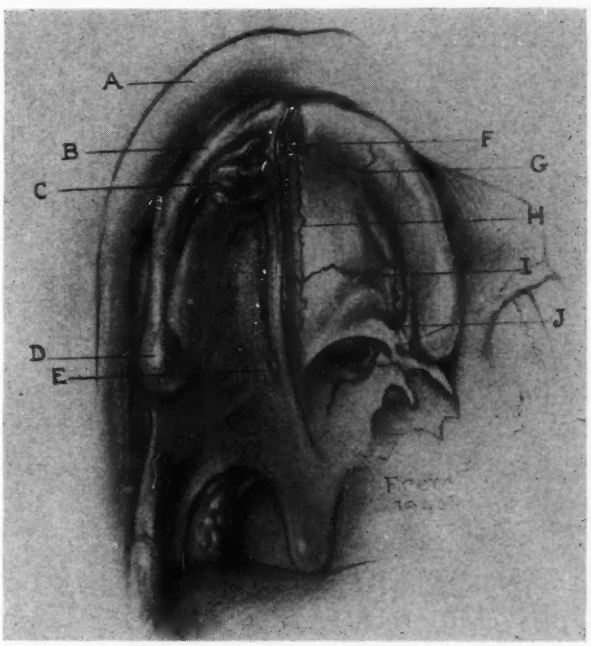


Fig. 1.—The anterior palatine foramen must be generously relieved so that the denture may not impinge upon the nerves and blood vessels that come through this foramen. Excessively hard rugae should also be carefully relieved. The posterior palatine foramen need not be relieved as it is covered with a thick layer of soft tissue. This soft tissue prevents the denture from compressing the nerves and blood vessels against the bony substance of this foramen. *A.*, lip; *B.*, ridge; *C.*, rugae; *D.*, tuberosity; *E.*, fovea palatina; *F.*, anterior palatine foramen; *G.*, anterior palatine or premaxillary suture; *H.*, median palatine suture; *I.*, posterior or transverse palatine suture; *J.*, posterior palatine foramen.
(Courtesy of Blakiston Co., from S. C. Miller, Oral Diagnosis and Treatment, p. 490, ed. 2, 1946.)

Presently, we are interested mainly in the retentive area:

1. The larger the palatal vault, within certain limitations, anteroposteriorly and laterally, the better the retention.

2. The smaller the area occupied by the torus palatinus, the better the retention.

3. The higher and the harder the torus, the poorer the retention.

4. The thinner the mucosa covering the palatal vault, the poorer the retention.

5. The greater the intimacy of contact between the denture and the palatal vault area, the better the retention.

These five principles of retention are effective when all other factors of retention remain equal. It follows then, that in order to secure good retention the upper denture must cover as much area as possible. Also, throughout its entire extent the denture must, if possible, be in intimate contact with the mucosa. If tinfoil numbers 17, 19, or 21 are used with a view to relieving the torus palatinus,

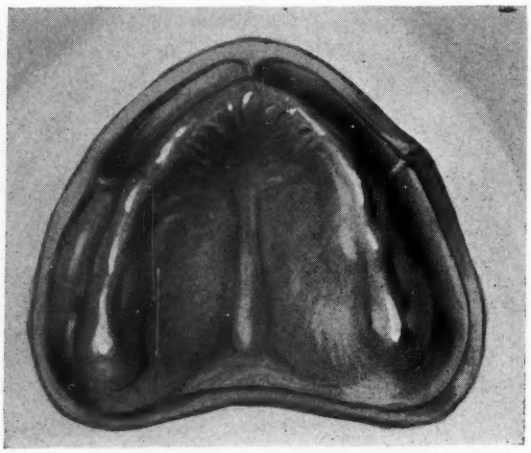


Fig. 2.—Torus palatinus covering middle portion and extending partly into posterior third of palatal vault.

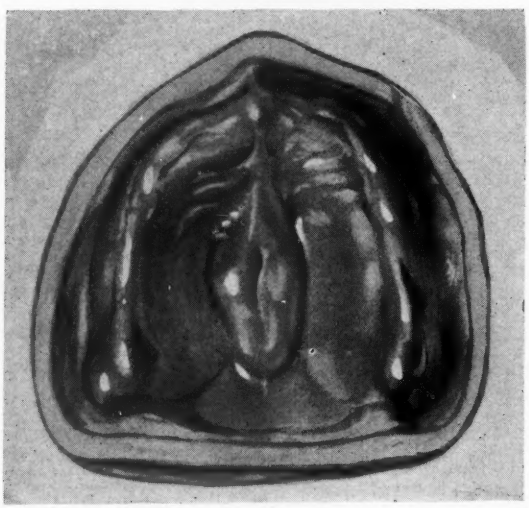


Fig. 3.—Torus palatinus extending over almost the entire palatal vault.

in the orthodox way, the retention of the upper denture is thereby reduced. This is because the area of contact between the denture and the mucosa becomes correspondingly smaller. If, therefore, the torus is generously relieved, the retention of the denture may become inadequate. If it is insufficiently relieved, the torus becomes a fulcrum upon which the denture will teeter anteroposteriorly and laterally.

It is, therefore, considered good practice to relieve the denture deeply enough to prevent its teetering at the time of its insertion with provision for anticipated settling in the future. Experience, however, teaches the wisdom of individualizing the management of the torus palatinus in accordance with the requirements of each case under treatment. This procedure will result in maximum retention and stability for each upper denture.

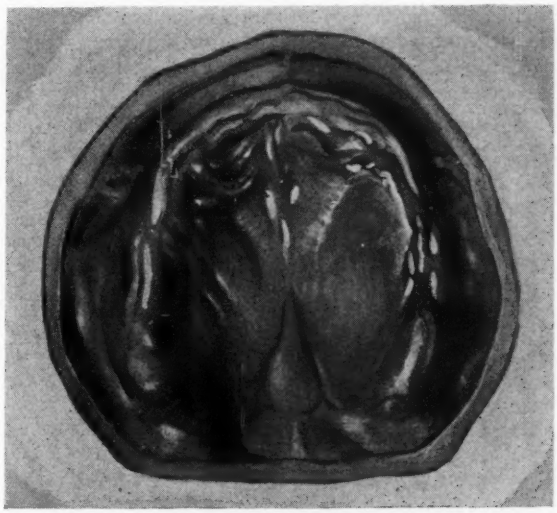


Fig. 4.—Torus palatinus located in the posterior part of the palatal vault.

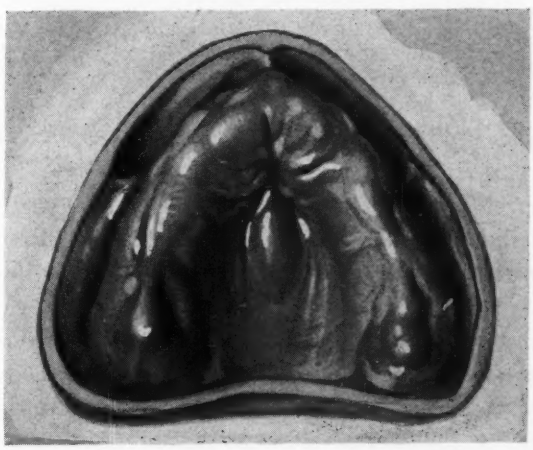


Fig. 5.—Torus palatinus extending mostly over middle third of palatal vault.

To achieve this a proper diagnosis is essential. It is important that the operator explore thoroughly the hard areas with the objective not only to establish their size, shape, and degree of hardness, but also with a view to ascertaining the manner in which they merge with the adjacent soft tissues. Visual examina-

tion alone cannot supply us with all this information. Digital exploration is by far more important for an intelligent diagnosis, because it helps us to determine not only the extent of the relief in an anteroposterior and lateral dimension, but in vertical depth as well.

Prosthetic men feel that the torus palatinus requires adequate relief in the greatest majority of cases. One reason for this view is that the torus usually is located farthest away from the periphery and is, therefore, subjected to greatest pressure by the impression material. Secondly, the mucosa is thinnest in this area and interferes with uniform settling of the denture. Whether the denture should be relieved at the time of its construction or later on, after it has been worn for a certain length of time and interference of settling is in evidence, is a matter of choice for the operator.

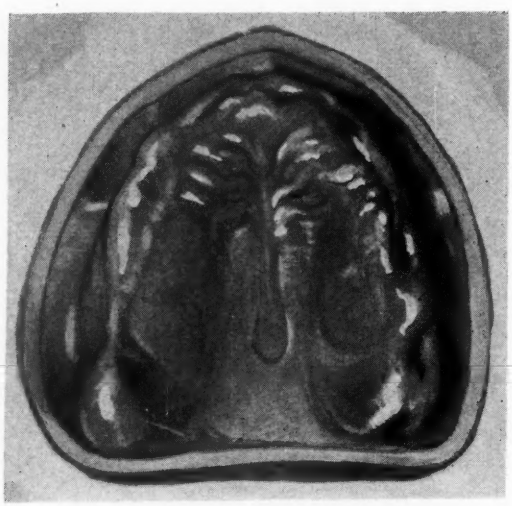


Fig. 6.—Torus palatinus covering approximately middle third and extending into anterior third.

Our own experience would seem to indicate that in instances in which the tori are not very pronounced but at the same time the prognosis for retention is *unfavorable,* it is best to postpone relief until required by settling of the denture. For this purpose a sufficient thickness of the denture-base material in the area of the torus will have to be provided for future contingencies. Additional two or three thicknesses of 28-gauge wax and of proper size, shape, and form are added on the lingual surface of the denture base corresponding to the region of the torus. When processed in this manner the denture will appear a little thicker than usual, but will allow for relief on its palatal surface when premature contact of the denture and torus becomes apparent after the denture has been worn for some time.

It must be borne in mind that when all the factors determining retention of the upper denture (shape, size, and form of the palatal vault, uniform thickness

of the mucosa, consistency of the mucosa, favorable saliva, and favorably placed muscle attachments of average resistance) are favorable, a slight mistake in the management of the torus palatinus is not of great significance. If we assume hypothetically that the relief of the torus reduces the retention of the denture by 10 per cent, the remaining retention (in the instance of a favorable prognosis) is still adequate, and the patient will be satisfied with the comfort derived. But if all or some of the above-mentioned factors of retention are unfavorable, the improper management of the torus may lead to a complete failure.

This is particularly true for patients that have never worn a full upper denture. Such patients are in need of the maximum denture retention which physical and biomechanical conditions of the oral cavity can supply in order to afford them the initial mental security so essential in adjusting to artificial dentures.

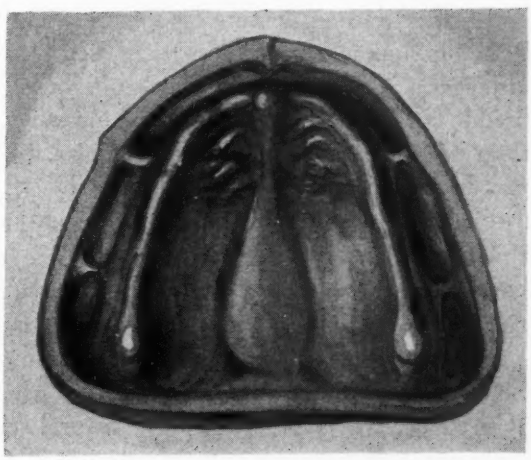


Fig. 7.—Torus palatinus extending over the entire surface of the palatal vault.

These patients will fare better if their tori that occupy large areas of their palatal vaults are not relieved initially, but, instead, relief is supplied by the dentist as need for it is manifested by the settling of the dentures. As the denture settles, the patient may experience pain or discomfort in the area of the torus where premature contact is effected with the denture. In other instances the patient will experience no pain, but the dentist will recognize the prematurity by severe redness or vascularization of the particular area of the torus. In still other instances, the premature contact of the torus with the denture will manifest itself in frequent fractures of the denture along its median sagital line. Here the torus acts like a fulcrum for forces exerted on occlusal surfaces of artificial teeth on right and left side. In addition, premature contact between the denture base and the torus may manifest itself by a reduction in the adhesive-cohesive forces of retention. The latter is effected by the intimacy of contact between the denture and its entire basal seat. Particularly, those areas of the basal seat that are

situated on right and left, front, and back sides of the torus palatinus. In these areas, the mucosa is thicker and will, consequently, permit greater intimacy of contact with the denture and with it—better retention.

However, the torus, being very resistant, may not allow this intimacy of contact to be effected by keeping the denture base, so to say, suspended. Proper relief of the particular premature point or area contact will in most instances improve the adhesive-cohesive retention. Therefore, gradual and careful relief of the denture as its settling progresses is conducive to better results in retention.

The management of relief of tori may be reduced to two procedures. One of the procedures may be designated as *preventive,* the other as *functional.*

Preventive relief of elevated areas, with a view to obviating lever action in denture bases with anticipated settling, subtracts from the sum total of their retention by adhesion. This is so because the area of intimate contact between the denture and its supporting structures becomes correspondingly smaller.

The *functional procedure* relieves dentures gradually while their settling progresses with function and is indicated in instances in which retention of the upper denture presents a problem. Also in cases in which the torus occupies too much area in length and width but not in height. Also in instances in which keeping the patient under observation does not represent particular difficulties, and relief can be provided for as the settling of the denture demands it.

Relief of dentures before they are processed or the *preventive method* of relief is indicated in the following instances:

1. When the torus is mushroomlike in form with undercuts.
2. When the ridges are soft and flabby and considerable settling is anticipated.
3. When the patient is an out-of-town resident, and close or frequent contact with him is not possible for observation purposes.
4. When a full upper denture is constructed to a natural complement of lower teeth.
5. When the full upper denture is to function in conjunction with a partial lower denture. (In the last two instances the full upper denture undergoes considerable settling under the impact of great pressure exerted by the natural lower teeth.)
6. When the roentgenographic examination discloses the alveolar process to be made up of very cancellous bone with the presence of a great number of nutrient canals. This type of bone is subject to rapid resorption under pressure with considerable settling of the upper denture following as a result.

The preventive method of relieving hard areas may be successfully accomplished by either of these two methods:

1. By scraping the impression to a carefully calculated depth, length, and width. The length and width of the torus must be relieved to their full extent. Failing to do that would mean that the torus has not been eliminated as a fulcrum, but its center has merely been transferred from one position to another.

2. By covering the hard area on the cast with metal of a certain desired thickness. Tinfoil No. 60 may be used for this purpose by superimposing two,

three, or four layers of it upon one another. These layers are so cut as to differ in size as well as in shape, and are superimposed upon one another in a manner that the highest and hardest portion of the torus gets the greatest relief in depth. In width and length these layers of tinfoil should cover the hard area to its fullest extent in all directions until it merges gradually with the adjacent soft tissues of the palatal vault.

The functional method of relieving hard areas, i.e., relieving the dentures as their settling progresses in function, can also be accomplished in one of two ways:

1. By transferring an indelible pencil mark from the denture upon the hard area.
2. By transferring the pencil mark from the torus upon the denture.

When transferring the pencil mark from the denture upon the torus both the denture and torus are dried thoroughly. The point of the indelible pencil is rubbed against the suspected premature contact area of the denture in a manner to leave a thick circumscribed layer of colored material. The denture is then introduced into the mouth and pressed against the palatal vault. If premature contact is present, the indelible pencil mark will deposit itself upon the corresponding area of the torus. This area should then be relieved with suitable stones and polished thoroughly.

The transfer of the pencil mark from the hard area to the denture is, as a rule, not as easily accomplished. It is frequently observed that the pencil mark is either not transferred to the denture at all or becomes smudged over a wide portion of its surface. In these instances, a small piece of white compound is made to adhere to the dry surface of the suspected premature contact area of the denture. It is brushed over with a hot blowtorch flame, tempered in hot water, and pressed quickly against the palate with force. In this way, the white modeling compound is thinned out to a tissue-paper thickness. The indelible pencil will readily transfer now from the hard area to the white compound on the denture base. It is then relieved first with a scraper for the removal of the pencil tinted white compound, and then with suitable stones to remove the premature contact area on the denture base. When physical and biological conditions of the oral cavity make retention of an upper denture very difficult, the proper management of the torus palatinus may spare the dentist and patient a great deal of grief.

REFERENCES

1. Miller, S. C., and Roth, Harry: Torus Palatinus, A Statistical Study, J.A.D.A., **27**: 1950-1957, 1940.
2. Landa, Joseph S.: Practical Full Denture Prosthesis, Brooklyn, 1947, Dental Items of Interest Publishing Co., p. 92.
3. Crich, W. A.: Torus Palatinus, Ontario Dental Association, **27**: 217-219, 1950.
4. Wright, Walter H.: A Method of Securing Correct Impressions, J.A.D.A., **27**: 1584-1590, 1940.

136 East 54th St.
New York City.

RELINES, REBASES, OR TRANSFERS AND REPAIRS

WILFRID HALL TERRELL, D.D.S.

Pasadena, Calif.

NO denture is permanent, and it is a misnomer to call dentures "permanent dentures." As we know, the mouth is continually changing, and in order to give our patients good denture service it is necessary not only to construct a good case in the beginning, but to be able to service those dentures for the patient for many years to come. Servicing the dentures means keeping them in proper function. There is a settling of the ridges which causes a closure of intermaxillary space affecting esthetics in the amount of tooth that shows, and also affecting the expression about the mouth when the mouth is closed. These are changes which need to be watched, as well as retention. Some men say they would rather use a flat mechanical tooth than an anatomic tooth so that as the ridges resorb and the mandible moves forward there will not be a locking of the teeth. I would rather have the teeth fitting in centric occlusion and guided there by their anatomic form, so when closure takes place, and soreness develops, it is a warning that there has been a major change, and that the vertical opening should be re-established. There was a proper overbite and overjet for the esthetics and function of the case when it was constructed. The loss of these relations when the mandible slips forward means that not only the patient's appearance is materially affected, but that function and comfort are certainly decreased. There is no guide to tell us where it belongs when flat mechanical teeth are used. The point has been made by many that trauma develops as the result of resorption of the ridges when anatomic teeth are used. I have been using anatomic tooth forms in my dentures for about twenty-five years, but have been taking particular pains to see that the cases are balanced, and that there are no points of cuspal interference. I have seen very few cases where the anteroposterior relationship has been lost as the result of resorption, for the teeth have been guided to a centric position. If the teeth are properly balanced, even soreness seldom develops to serve as a warning that the denture space should be re-established. However, general appearance usually shows this, and measurements from profile records can be used to measure it. You and I have seen lots of cases built with flat cusp teeth in which there has been a closure, and the mandible has slipped far forward from the position in which the case was constructed. The patient has nothing to hold those dentures in proper relation to each other. Ridges will resorb under dentures regardless of whether the teeth are flat or anatomic in form. Neither type of tooth functions properly

Reprinted from the Dental Journal of Australia, 22:411, September, 1950.
Read at the Twelfth Australian Dental Congress at Sidney, Australia, August, 1950.
Received for publication March 22, 1951.

in an overclosed relationship. After we purchase a new car, we do not expect to wear it out without service on it. By proper servicing of that car, its life can be extended and its value to its owner greatly increased. It functions properly and causes little trouble. Servicing of dentures is just as important as servicing of a car. Patients should not expect to have those dentures last them the rest of their lives without a certain amount of servicing. Either they should be serviced, or new dentures made about every seven to ten years in order to keep up with the changes in the mouth. If the fact that these changes are going to occur has not been explained to patients in the beginning, they are apt to blame the dentist for the fact that their dentures do not function properly or look as well as they did originally. The chances are they will find a new dentist the next time. They might be interested in new dentures due to the fact that there is a continual advancement in denture materials and teeth, and, as you know, we can build much better dentures today than we could ten years ago. We are going to see many improvements within the next ten years.

Fig. 1.—Heater for impression gel.

I do not reline, rebase, or transfer dentures made by other men, but this service is available for all patients for whom I have made the original dentures. Esthetics and function both can be easily lost in this process unless a precision technique is followed.

Before going further, let's define these different terms. The definitions which I give are not from a dictionary, but I think they will explain what I mean. (1) Relining is giving the denture a new acrylic lining. It is done by taking an impression in the dentures and replacing this impression material with new plastic. In this process, a layer of the old acrylic is removed and the borders are cut back in order to get a good union of the new material with the old. We do very little

relining. It is confined principally to partial dentures. (2) Rebasing and Transferring are identical terms in meaning. They are the constructing of a new denture base around the original teeth. This is done by taking an impression in the denture and then after preserving the position and relation of the teeth to the ridges, the denture base is entirely replaced with new material (see Fig. 1). In other words, we have given those teeth a base of new acrylic. If the posterior teeth have been ground or worn, these can be replaced with new posteriors during this process. The original anterior teeth will not be disturbed. Obviously, the charge for transferring must be more than for relining as there is much more work involved, but it makes a denture like new when completed. The completion of an immediate restoration six weeks or more after the case has been inserted is always done by transferring.

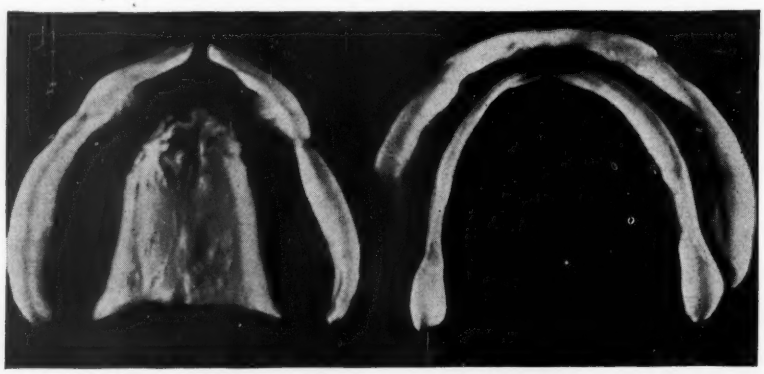


Fig. 2.—Impressions made with impression gel.

REBASING TECHNIQUE

The following is the technique used for rebasing and putting the front in an immediate restoration. After removing all the undercuts, the tissue surface of the upper denture is painted with the impression material to be used and gently settled to place (see Fig. 2). The best way to seat the denture without exerting a greater pressure on one side than on the other is to press in the center of the vault upward and slightly backward parallel with the path of insertion. Since there is likely to be protrusion in taking such an impression, and due to the fact that the settling of the upper denture is usually upward and forward, it is important that this impression be seated in an upward and backward direction. No heavy pressure is exerted whatsoever, and when the denture has been seated as far as is required for esthetics, all pressure is released and the material is allowed to set with the tissues at rest. When the impression is removed, it is examined for any necessary corrections. After these are made, the chair is placed in a horizontal position and special impression plaster or Truplastic is mixed. This is placed around the entire peripheral border of the denture and across the anterior surface of the ridge. It is done in the same manner as the final impression for the upper denture in our precision technique with the patient closing on wet cotton

rolls while the material is applied. The patient is instructed to move the lips forward and backward as in whistling and smiling. The cheeks and lips are then pressed inward to mold the border and eliminate excessive thickness at any point. Usually in the anterior very little thickness is required on the peripheral border, and care should be taken that it is not left too thick. It is better to mold the border to the thickness we expect to have in the completed denture than it is to leave it over-extended, and have to grind it down later. When the impression is thoroughly set, the patient rinses the mouth with water, and the impression is carefully removed.

Fig. 3.—Protrusive wax bite.

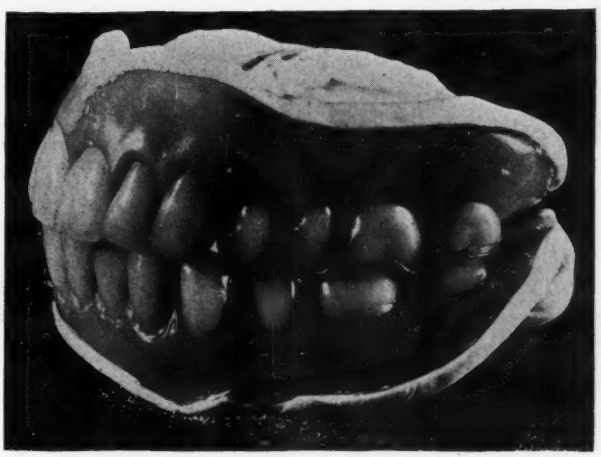


Fig. 4.—After impressions are complete, centric is taken in soft wax.

We then mark the line for the post dam and the palatal seal of the upper denture with indelible pencil. This is transferred to the impression. The lower impression is taken in the same manner. Next, a protrusive wax check is taken, being careful to stop the patient's closure just before the incisors contact (see Fig. 3). Next, Kerr's Plastic Wax (which is a very soft low-fusing wax similar to carding wax in consistency) is flowed on the occlusal surfaces of the upper posterior teeth (see Fig. 4). The chair is again placed in a horizontal position with the head well back, and the patient is instructed to move the mandible forward and backward until the heads of the condyles reach the posterior surfaces of the glenoid fossae.

The dentures are then put in place, and the patient is instructed to roll the tongue as far back in the roof of the mouth as possible. When the mandible is back, with the condyles in the glenoid fossae, the patient is instructed to close slowly and lightly into the wax which had been placed on the upper teeth. Have the patient close several times with a light tapping motion. It will be found, if the mandible is back in position, that the patient will continually strike in exactly the same spot. This is repeated many times until the tips of the porcelain are beginning to contact. Any pressure beyond this point would introduce malocclusion. If there has been closure of the vertical dimension it can be opened by the impressions, and the occlusion can be re-established by this method. The occlusion should always be

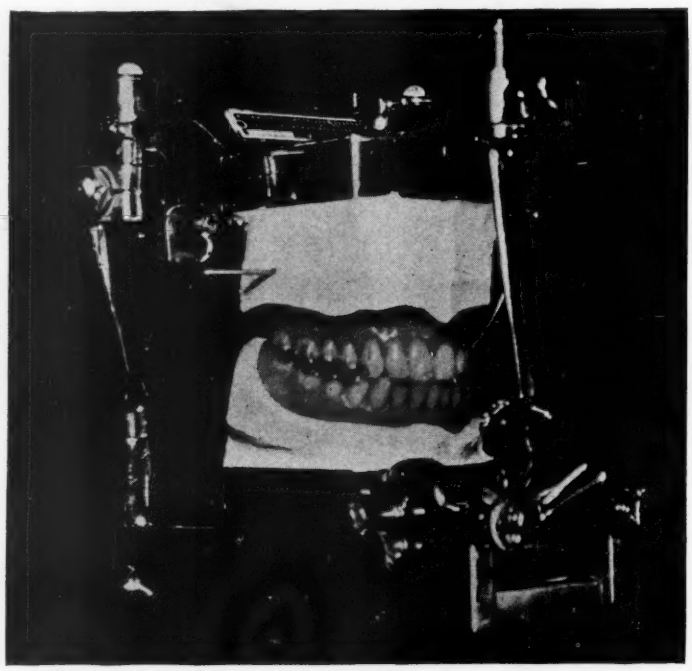


Fig. 5.—Cases are mounted on articulator in centric.

re-established after taking impressions for all transfers or relines. Patients will develop a protrusive bite, but the greatest comfort will be had when the centric relation of the dentures corresponds with the centric jaw relationship, or mandibular centricity. Centric jaw relation exists when the heads of the condyles are in their most comfortable retruded position from which lateral and protrusive movements can be made at a given vertical opening. The casts are then poured being careful not to injure this centric relationship which has been taken against the soft wax on the upper teeth. The casts are now trimmed and mounted to this centric position by some split cast method (see Fig. 5). When the wax has been removed from the teeth, often it will be found that they will not close into their original centric. This we do not worry about, for it is one of the things that

needs correction and is usually overlooked. Next the protrusive wax record is placed between the teeth, and the condyle adjustments of the instrument are set accordingly (see Fig. 6). The record of the condylar information should be marked on the side of the cast with indelible pencil. There will be an apparent malocclusion which is just as important to correct at this time as is the fit of the dentures. Usually the lower denture is removed from its cast first, and the

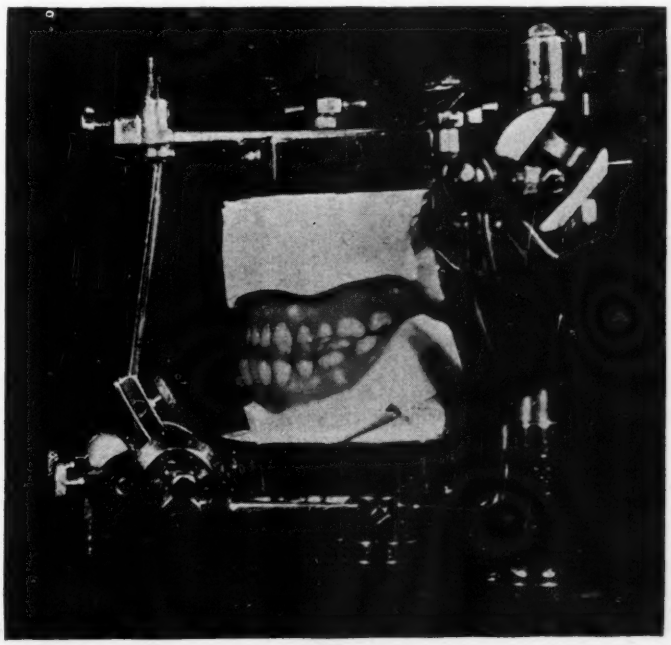


Fig. 6.—Articulator is adjusted with protrusive wax bite.

Fig. 7.—Post dam and palatal seal is made with a number eight round bur.

impression material eliminated from both the denture and the cast. The remaining plastic is then cut away from the teeth both on the labial and lingual, leaving only enough along the under surface to keep the entire arch of teeth tied together. They are then attached to the upper teeth with sticky wax to correct centric position and the articulator is closed. The space between the mandibular cast and the teeth is then filled in with wax. The denture is then waxed to proper contour, rechecking the accuracy of the occlusion in centric, lateral, and protrusive positions. The upper denture is next lifted from its cast and all impression material removed. The upper cast is then post dammed and a palatal seal is added by using a No. 8 bur (see Fig. 7). The acrylic is cut away from the labial, buccal, and palatal surfaces of this denture leaving only that on the under surfaces of the teeth to keep the entire arch of teeth tied together. They are then attached with sticky wax into proper occlusion with the lower teeth and the space between the teeth, and the

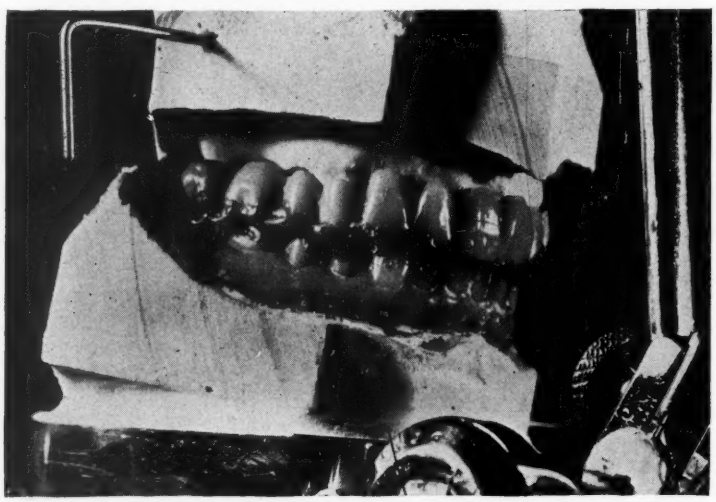


Fig. 8.—Teeth are waxed into centric of opposing bite.

maxillary cast filled in with wax after the articulator is closed (see Fig. 8). If the rugae are to be reproduced this is done by burnishing a template of .004 tin foil into the rugae area, swaging it by means of a stone counter die. The counter die is previously made by pouring stone into the palate of the cast. A few thicknesses of rubber dam are placed over the tin foil and the counter die pressed to position. This foil is then trimmed, and after an even thickness of Kerr's Boxing Wax (red) has been placed over the palate, the foil is pressed to place over this wax by means of the counter die. This gives a duplication of the patient's natural palatal contour. Attention should also be paid to contouring the plastic below the lingual of all the teeth which eliminates an excessive amount of thickness in this area. It adds much to the patient's speaking ability.

After the cases have been cured they are remounted on their split casts on the articulator and the occlusion corrected and milled (see Figs. 9 and 10). Dentures

transferred in this manner will give the patient an efficient case with all new base material and still retaining the esthetics of the original dentures. Nothing is lost in the process.

RELINING

Relining is done in the same manner except that instead of removing all of the plastic from the buccal and labial surfaces we cut out only the palate of the upper denture and grind out a certain amount of base material on the tissue surface of both dentures to allow for the desired thickness of the new material.

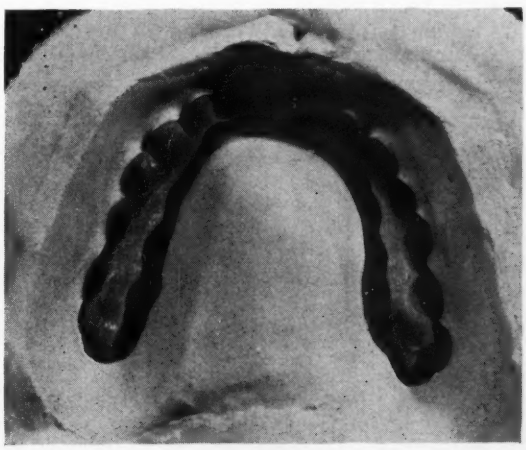


Fig. 9.—Teeth flasked ready for packing.

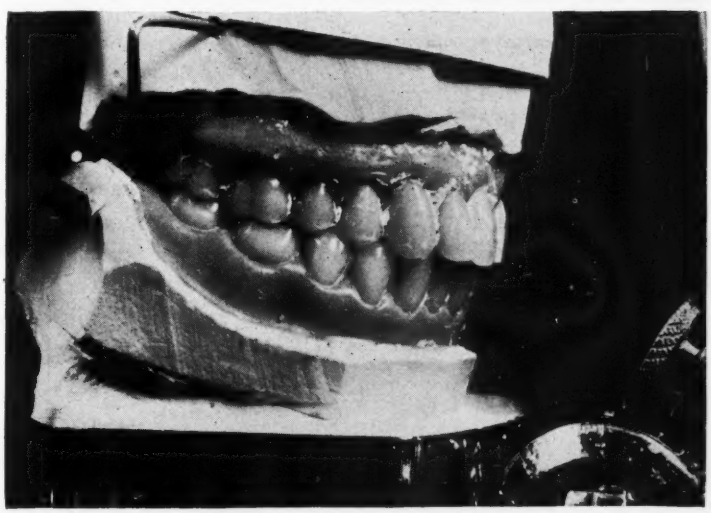


Fig. 10.—After cases are cured they are remounted, spot-ground, and milled.

The same procedure is followed as far as maintaining or correcting the occlusion as was done in transferring. If only one denture is involved a metal cast is made of the opposing occlusion (see Fig. 11). This is mounted on the articulator with the same records as previously described for transferring.

ACTIVATED RESINS

Most methyl-methacrylates would eventually polymerize at room temperature, but this is a very slow process. At the present time we do have rapid curing resins which are used for quick repairs and relines. Heat is not required for these to polymerize and they probably do have a place among our denture materials. However, at the present time there are none that have proved suitable for relining purposes. They can be used for quick repairs for replacing teeth, but should be used only for emergency repairs, and not generally in place of the better type of acrylic resins.

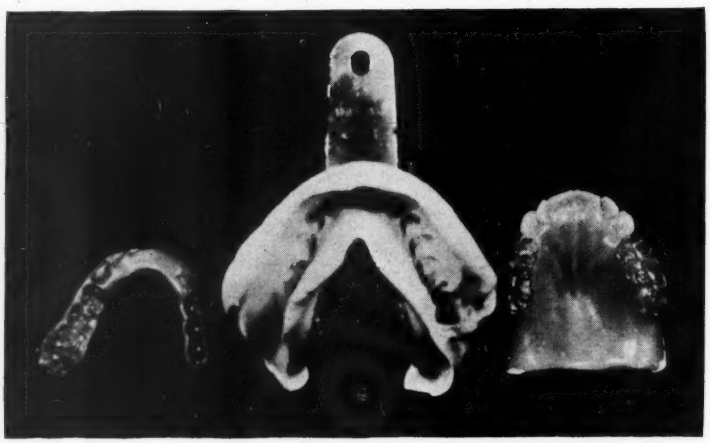


Fig. 11.—Protrusive, centric, and impression for a metal model.

Those relining materials which are advertised for patients to place in their own dentures should by all means be avoided, as they have been proved to be quite injurious to the mouth tissues in many cases, and to cause warpage of the dentures. They do not form a perfect bond with the acrylic of the denture, and therefore should be discouraged except for emergencies. Skinner and Pomes definitely proved that warpage occured by the application of these liner resins. They penetrate the inner surface of the denture, affect the consistency of the methyl methacrylate on the tissue side, and cause the denture to warp.

REPAIRS

Acrylic repairs, relines, and rebases should be done, when possible, with the identical material from which the denture is made. Quick repair materials should be used only in emergencies. It is important that all repairs be made at a low

temperature for it has been shown that polymerized methacrylate resin will expand at 180° F. and that the material will expand in proportion to the temperature applied. It is therefore dangerous to place it in boiling water as it is apt to produce strains and warpage due to this expansion. It is therefore recommended that all repairs be made at a temperature from 160° to 165° F. for two and one-half hours or more. While the repair acrylic will form a bond with the polymerized methacrylate resin of the denture it is best to use mechanical retention as well. Where there has been a complete fracture, after the cast has been poured, the fracture should be opened up all the way through. The surface on either side of the channel should be rabbeted about one-half the depth of the material. Before packing, some of the monomer liquid should be put on this surface several times so that it softens the acrylic and forms a bond with the new material. Before a denture is repaired the cause of the breakage should be determined. It may be due to the absorption of the ridges and a fulcrum being developed thru the center of the denture, or it may be due to porosity of the material or to thinness of the material which causes the fracture. This should be determined first, for if it has been caused by the resorption of the ridges, an impression for relining or rebasing should be taken in order to prevent its reoccurrence. In either relining or rebasing an upper denture the safest procedure is to always cut out the palate and replace it with new material. This will give an even thickness of material and added strength will prevent future trouble. Our motto should be, not how quickly can we do our work, but how well can we do our work. Not how quickly will it be finished, but how long will it last. Our reputation is at stake with every piece of work that goes out of our office from the smallest repair to the most complicated reconstruction, and while there is little money in repairs they should not be taken lightly and never done inefficiently.

627 First Trust Bldg.
Pasadena, Calif.

ALVEOLOPLASTY IN PREPARATION FOR THE IMMEDIATE DENTURE INSERTION

J. Roy Bourgoyne, B.S., D.D.S.*

Memphis, Tenn.

THE term "alveoloplasty" simply means any operation which consists of the removal or excision of a part of the alveolar process. Dr. D. E. Jenkins[1-4] of the University of Omaha provided the term "alveolectomy." In the beginning Jenkins was of the opinion that only the external plate of the alveolar process should be removed. However, this was not always true, the mucoperiosteum of both the buccal and lingual areas is sometimes reflected, the diseased and other undesirable tissue removed, and the stressbearing areas of the ridges rounded and smoothed over.

Alveoloplasties were performed as early as 1853. In this year, A. T. Willard[5] of Chelsea, Massachusetts, wrote for the Dental News Letter of the preparation of the ridge of a patient after he had extracted teeth. This operation was considered, at that time and for several years later, heroic treatment. Today, alveoloplasty is no longer considered as such but rather as a necessary treatment in preparing the mouth to receive artificial dentures or to enable the patient to resume normal mastication.

Other references to alveoloplasty as such are few in the period surrounding 1853; however, there are numerous cases on record where the alveolar process was involved and treated. These cases were for the most part concerned with the repair of fractures, gunshot wounds, or treatment of areas of necrosis or gangrene.

In 1872, a discussion on trimming of the alveolar process and on alveolar resorption appeared in the Dental Register.[6] There was no author's name attached to the article, however.

Although Dr. Jenkins is given credit for the term, "alveolectomy," a review of the literature leaves one vague as to just whom to give credit for originating the procedure of the operation as we know it at the present time.

In 1905, Dr. William L. Shearer[3, 4] of Omaha performed the operation claimed by some to be the first. In 1908, Young[7] wrote for the Dental Cosmos on "The Treatment of Prominent Alveolar Process." The object of the operation, which he described in detail, was the removal of alveolar processes that protruded in order that the prosthodontist would have no trouble adapting a denture in the manner

Read before the Oral Surgery Section of the American Dental Association at Atlantic City, Nov. 1, 1950.

Received for publication March 1, 1951.

*Chief of Division of Oral Surgery, University of Tennessee College of Dentistry.

he desired. This operation was most definitely the alveoloplasty as we know it today, but if his procedures were adopted by other dentists at that time the literature showed no evidence of it.

In 1917, a physician, Dr. H. A. Potts,[8] wrote of "a new operative procedure facilitating the adaptation of artificial dentures." Potts' idea was the same as that of Young; that is, by an operative procedure make a normal arch or ridge out of an abnormal one to facilitate denture adaptation for the prosthodontist. He described the technique of his operation in full and presented it to the professions. He also stated in his report that he had reviewed the literature and had found no report of an operation such as his, and that he had consulted with "some of the leaders in dental thought" and found that his operation and ideas were new to them.

Dr. Chalmers J. Lyons,[8] in a discussion of Potts' operation, said, "This is the first operation of this kind that has been called to my attention, but I can see the good that can be accomplished in a great many of these seemingly impossible cases for the fitting of artificial dentures. This procedure should be brought to the attention of men working in prosthetic dentistry."

In view of the preceding statements it seems as though Potts has made a strong bid for the credit for origination of the operation we now call alveolectomy or alveoloplasty.

Our present conception of alveoloplasty pertains to the correction of the contours of the alveolar ridge. Some members of the dental profession believe that the term alveolectomy is a misnomer and that alveolotomy more properly refers to the operation since alveolectomy would indicate the entire removal of the alveolar process. However, the writer, along with several others, prefers the term "alveolopasty," due to the fact that it is actually a plastic repair to the ridge.

Potts stated that the removal of bone spicules and osteoid growths to gain greater denture comfort, and the removal of undercuts to favor atmospheric pressure as the most important factor in retention were the two reasons why his operation was indicated in some cases. Adaptation and adhesion were considered by Potts to be unimportant factors in the retention of a denture. He believed atmospheric pressure to be the most important factor in retaining a denture in place. Thus he claimed that his operation promoted the use of atmospheric pressure. The following statement was also included in Potts' report of his operation. "The removal of exposed, projecting process after extraction should be more frequently done than is our habit."

A review of Potts' report was contained in the dental journals of that year, and the literature has contained articles and discussions on alveoloplasty consistently ever since that time.

In 1918, Ruyl,[9] a prosthodontist and a pioneer in the work of alveoloplasty, described an operation that he had performed to restore abnormal mouths to normal conditions in order to facilitate the insertion of dentures. His approach was very practical and his objective was that of gaining a more satisfactory ridge on which to place his denture. The article written by Ruyl indicates that he was unaware

of the work of Potts. Wald, an observer and follower of the Ruyl technique in detail, gave credit to Ruyl as being the first man in this country to perform such an operation.

In 1919 a detailed description of Ruyl's operation and a complete list of materials and instruments was described by Wald.[10] Some interesting points of this description that merit relating were that Ruyl used a 7-A wax spatula as a periosteal elevator, and that he placed a band around the patient's head to which hooks were attached to serve as anchors for tissue retractors, which held the maxillary periosteum away from the field of operation, allowing the use of both hands of the operator in carrying out the operation.

Many men of this time were vigorously opposed to the operation since many of them were not using anesthesia for extractions, and because their knowledge of the anatomy of this field was not universally intimate. To perform an alveoloplasty in each case of multiple extractions was a marked departure from their previous technique and practices; therefore, they were opposed to the change as is the case when most advances are first introduced to the dental and medical professions.

Opposition to alveoloplasty was largely based on ignorance and a natural desire to remain with the multitudes. As late as 1927, Shearer[11, 12] wrote that alveoloplasty was indicated in cases where there was enough pathology to warrant the opening of the area to remove bony processes. He gave no reason why bony processes should otherwise be removed.

One argument against alveoloplasty was that the removal of the labial plate would impair the regeneration of bone. We know today that this belief has no sound basis. There are, however, operators in the field of dentistry today who believe that the labial or buccal plate should not be removed unless it was fractured as a result of the extractions. They base this assertion on the fact that a better base for a denture results if the labial or buccal plate is left intact.

About ten years after the idea of doing an alveoloplasty was introduced to the dental profession a dentist, also named Potts,[13] wrote an article opposing the idea. He was moved to do so because he thought the dental operators had become overenthusiastic about the procedure. He stated: "The majority of mouths need no meddling preparation for dentures, and I see no valid reason why the patient should submit to a dangerous operation just to make it easy for a dentist to make a denture. Long before the desire to cut, file, and grind bone and cover up iniquity by suture of the gum tissue developed, most dentists did all the surgery necessary by nipping sharp and projecting processes, with the result that the patient had less discomfort and pain and better bases on which to build dentures." Other objections of Potts were against the breaking down of the lamina dura, which he said was a protective structure that isolated the infected tooth from the blood and lymph streams, and the bad practice of using the curette to remove the mass of granulation tissue "that is the only means of repair." He advised, "The surgeon has thrown his curettes away and the dentist should not begin to use them."

It is easy to understand why the practicing dentist did such radical surgery of the alveolar process when one considers that many of the students of dentistry of that time were being taught that it was the proper thing to do. Most of our dental students of the 1920's were taught that the alveolar process was a transitional tissue that came with the eruption of the teeth and went with the extraction of them. However, it was observed by some that this was not true if dentures were placed on the ridges within a reasonable length of time. These observant operators found that a large portion of the alveolar ridge would remain if dentures were placed, and that nature only resorbed the ridges rapidly in cases where a correctly fitted denture was not worn. Smedley[14] called this "resorption due to disuse atrophy."

Those conservative dentists who believed in leaving the alveolar bone and also many undercuts advanced the following reasons for so doing:

1. Moderate undercuts often aid in denture retention.
2. Facial expression may undergo a complete change if there is excessive removal of anterior undercuts.
3. Regardless of undercuts, the broader the base the better the support for a denture.

Our present theories concerning alveoloplasty are more prone toward better choice of cases which might be placed in the class of conservatism by some operators. Most likely this is due to experience and observation and better knowledge of the physiology of the alveolar processes and associated structures.

Indications for alveoloplasty differ with the requirements of the case at hand. Since this operative procedure is described most often under the field of minor oral surgery we might do well to review the words of Dingman and Hayward,[15] who said: "Successful management of minor oral surgical problems presupposes steadfast and slavish adherence to the principles of hemostasis, asepsis, and anesthesia, as well as a knowledge of anatomy, pathology, and physiology of oral tissues. An accurate diagnosis and clinical evaluation of the problem is imperative before the dentist undertakes any surgical procedure. In addition to the factors mentioned, surgical and technical ability play an important role in the successful conclusion of a case."

Indications for alveoloplasty for each must be established by the operator's clinical experience, clinical examination, and roentgenographic examination, and they may be as follows:

1. Excessive growth of the tuberosities.
2. Torus lingualis.
3. Torus palatinus.
4. Exostosis.
5. Severe undercuts of the alveolar process.
6. Excessive amount of alveolar process remaining following extraction.
7. Rough bone margins following extractions.

8. Root fragments retained following extraction.
9. Impacted or supernumerary teeth.
10. Sharp, bony projections which irritate overlying gingival tissues.
11. Pathologic areas within the alveolar process.
12. Presence of large masses of hypertrophied tissue.
13. Improper relationship to the arches.
14. Esthetic considerations.
15. The desire for immediate dentures.

The overgrowth of bone in the tuberosity area is thought to be congenital. This condition of the tuberosity may have severe undercuts when the teeth are extracted and the insertion of dentures may produce pain. This overgrowth may leave insufficient space between the arches for the construction of dentures. If this be the case, then surgery is definitely indicated. Some operators who advise leaving undercuts where possible advocate surgery only on one side in the cases with severe undercuts. In such cases the undercut side of the denture is applied first when insertion is made.

The removal of tori does not necessarily fall into the class of an alveoloplasty. In cases where tori are not too extensive they may be left to remain if trouble is not anticipated.

An exostosis is a congenital or acquired overgrowth of the bone. If it occurs on the alveolar ridge it may cause an irregular outline of the ridge and an undercut which might be severe enough to warrant its removal to avoid serious interference with placing prosthetic restorations or normal mastication.

Severe undercuts of the alveolar processes such as in the tuberosity area or as seen in the anterior part of the maxillary ridge may be due to a normal overgrowth of the bone or caused by careless extraction of teeth in which the labial or buccal plate was fractured and sprung outward and not pressed back into place.

Some patients have a short upper lip which will not hide the base material of dentures. The esthetics of such a case in many instances can be improved by the removal of a portion of the ridge.

The margins of the bone should be smoothed when extractions are done to facilitate healing of the tissues. When this is not done it may become necessary to reopen the tissues and smooth these margins so that normal healing may occur. These areas also may become irritated and painful when a prosthetic appliance is placed upon them.

Root fragments left in the alveolar bone often become sources of irritation and foci of infection when dentures are placed over them. It is the opinion of the author that removal should be done when these are discovered.

Impacted and embedded teeth, whether they are supernumerary, deciduous, or permanent, may act very much in the same manner as root tips, and may be stimulated to eruption in some instances by the placement of dentures. They are a definite hazard to the placement of dentures and should be removed when found.

Sharp bony projections should be removed at the time of extraction since they cause pain and irritation to the tissues during healing and also when dentures are placed, thus necessitating an alveolectomy after the dentures are inserted.

Pathologic involvement of the alveolar process may be due to infected teeth or may exist as diffused latent infections. These areas should be removed with the least possible bone destruction so that some form of ridge is left for the patient.

The presence of large masses of hypertrophied tissue on the ridge may also prevent the proper adaptation of dentures. These masses may be removed so that a more normal ridge is obtained.

Improper relationship of the arches to each other can be corrected only to a limited extent by the alveoloplasty. A slight abnormality may be entirely corrected or a severe condition reduced in severity, but usually the surgery necessary to correct a marked abnormality would greatly alter facial contour and phonetics. It is considered by most that these cases be handled by the prosthodontist who through mechanical skill, dexterity, and ingenuity may gain optimum results without resorting to surgery.

An alveoloplasty is often indicated for esthetic results in cases of extreme anterior, horizontal overjet. There are numerous reports in the literature which show cases that have been improved greatly by removal of the anterior teeth and replacing them with prosthetic appliances. They then show marked improvement in facial expression and contour plus a more favorable mental outlook for the patient.

Probably the most prevalent indication for alveoloplasty today is the desire for immediate denture service. For such a service the alveoloplasty is necessary in most instances. From the standpoints of preservation of the alveolar ridges, more rapid healing, esthetics, and general comfort of the patient, immediate denture service is indicated whenever possible. Some of the more important advantages of immediate dentures are as follows:

1. Immediate dentures preserve the tone of the muscles and surrounding structures and protect the temporomandibular joint from the dangers of reduced vertical dimension.

2. It is possible to place the teeth in their former indicated positions, thus obtaining the same arch contour, the same arch position, the same size and shape, and the same individual rotational positions and inclinations that the natural teeth possessed.

3. Better ridges result because alveolar resorption is less and better controlled.

4. There is usually less pain, because the denture acts as a protective splint for the open wound, and thus aids healing.

5. The patient need not go through the humiliating edentulous period of healing.

Contraindications for alveoloplasty must be determined by the operator after he has examined the patient and taken a history of the case. As have been previously described in the literature by Dingman and Hayward,[15] the constitutional

or general conditions that would contraindicate minor oral surgery may be classified under two headings as "general conditions" and "local conditions."

A. General Conditions

1. Blood dyscrasias such as leucemia, hemophilia, agranulocytosis, or any of the common anemias.
2. Uncontrolled diabetes mellitus. If diabetes is suspected, the patient should be referred to a physician and no surgery undertaken until the physician gives his consent.
3. Syphilis. Alveoloplasty is contraindicated in such a case due to the danger of the operator acquiring the disease as well as dangers to the patient.
4. Tuberculosis and certain pulmonary, cardiac, and renal diseases all contraindicate alveoloplasty because lowered resistance coupled with a condition of shock could well be fatal, and at best is still too great a risk for the operator to take.

B. Local Conditions

1. Local infection.
2. Any conditions contraindicating extractions such as:
   a. Severe oral sepsis
   b. Accumulation of calcareous deposits on the teeth
   c. Poor oral hygiene
   d. Hyperemia of the soft tissues
   e. Vincent's infection
   f. Pericoronitis
   g. Previous deep x-ray therapy in large doses

The removal of bone from the maxilla and mandible is performed, as a rule, to reshape and contour the ridges for the reception of dental appliances. The oral surgeon must construct the foundation for the denture in such a manner that it will have the stability and contour to receive a denture. The case would be a failure if the foundation would not allow functional manipulation of the denture, just as it would fail if a poorly constructed denture were placed on a good foundation.

A general classification of the conditions requiring surgical correction is outlined by Templeton[16] as follows:

1. Prominent upper anterior ridges.
2. Prominent buccal plates.
3. Excessively large tuberosities.
4. Torus mandibularis.
5. Torus palatinus.
6. Prominent knife-edge mylohyoid ridges.

The majority of conditions requiring correction are located in the maxilla. Mandibular anomalies are in the minority. There are some instances where alveoloplasties are indicated in which teeth are present where roentgenograms disclose very dense bone surrounding the roots. Surgical removal of these teeth is preferred by many authors as it prevents unforeseen fracturing of the labial and buccal plates. The technique for immediate dentures falls in this category, and the surgery involved will be discussed later in this paper.

When a patient presents himself for denture service, a full mouth set of roentgenograms is necessary for both the prosthodontist and oral surgeon. Impressions and casts poured and mounted are helpful. With the loss of the first permanent tooth, the extraction should be treated as readying the patient for future dentures and appliances.

It is now recognized that the prosthodontist and oral surgeon must collaborate when the surgical preparation of the alveolar ridges is being considered prior to instituting denture service. Since the alveolar ridge is the patient's last line of defense against being a dental cripple, surgical treatment should at all times be conservative.

Frequently at the tuberosity there is found bone in such excess that it contacts the lower ridge when the jaws are in centric position. Obviously, there will be no space for prosthetic appliances until this excessive bone is removed. To correct this abnormality, one method suggests taking out a wedge-shaped section of tissue and removing the alveolar buccal undercut, after which the flaps are brought into opposition. Beginning at the tuberosity, the molar and premolar regions are prepared. The septa are shaped to produce a "U," with a long slope on the buccal side. The lingual plate is reduced little if any, other than to smooth sharp margins. The proper contour is obtained with the rongeurs, burs, and chisels, while the bony edges may be smoothed with files. All debris is carefully removed from the area. The jaws are brought into centric relationship to determine if the proper amount of bone has been removed in order to receive dentures properly.

Other conditions to be dealt with frequently are those of bone tumors, exostoses, or tori, as they are commonly called. These abnormalities are more frequently found on the mandible. They are also found on the palate along the midline or median raphe. In comparison the removal of the torus mandibularis is more simple than that of the torus palatinus. Concerning the torus lingualis, the bony nodule may be exposed and notched or furrowed in several places with the bur, the remaining portion broken off with the chisel or elevator and smoothed with files. The torus palatinus presents a more complicated surgical picture. The removal of this torus should be undertaken by skilled and experienced men possessing detailed knowledge of the anatomy involved. The danger of perforating the palate is obvious, owing to its position and function.

A midline incision is made extending well anteriorly and posteriorly past the nodule. The bony mass is exposed by elevation of the tissue with the periosteal elevator. Some operators prefer the use of chisels to remove the bone; however, in the opinion of the writer this technique is considered hazardous.

The following technique may be executed with success if it is carefully handled. A fissure bur is sunk into the torus at several different places, leaving columns of bone which can be snapped off easily with an elevator. The base is then smoothed to the desired thickness with bone burs or files.

Due to the previous extraction of teeth and improper ridge contouring prior to the need for dentures, there may be areas in the posterior region which are very sharp, called "knife-edge" ridges. The high thin ridge does not furnish the retention or support or remain as stable as does the flatter and broader type of ridge. To correct such a condition an incision is made along the crest of the ridge mesial and distal to the bony spine area. The mucoperiosteum is reflected to fully expose the ridge. The rongeur may be applied to the alveolar spine, and the bone file used for finer smoothing. If the ridge still feels irregular, large bone burs may be used to further smooth its crest.

The procedure where the flap is turned before extraction is known as the surgical technique. Instead of using the forceps to remove teeth forcibly, the alveolar bone is chiseled away over the roots of the teeth which are then lifted out. This method seems to control better the amount of bone that will be removed, as a fracture of the buccal or labial plate by using the forceps might necessitate the trimming of the ridge to an undesirable contour.

A simple procedure may be all that is needed to develop an arch that gives adaptation and esthetics rather than one that affords no retention and poor esthetics. One with a broad square face and skull contour often needs little surgical correction of the arches other than smoothing and removing sharp prominences. The type most often requiring surgery has a long, slender face with a high palatal vault and narrow arch. This individual when smiling shows a great deal of gum tissue above the teeth.

A protruding over-developed alveolar process in the anterior region of the maxilla may be so extensive as to cause a major discrepancy in the inter-jaw relationship. In cases such as this, there will be a dependence upon the discretion of the operator and the extent of the abnormality whether immediate or conventional dentures would offer the better service.

In those alveoloplasties preceding the insertion of immediate dentures, the technique is somewhat altered from that for the conventional dentures. Here the ridges must be shaped and contoured to a specific form as the dentures have already been constructed. This may be accomplished by means of a clear acrylic surgical template which was constructed over the cast that was previously trimmed to the desired shape by the surgeon or prosthodontist.

The mucoperiosteum is reflected slightly past the area of operation to avoid injuring these parts. This also prevents removing bone from the cul-de-sac and destroying the peripheral seal of the denture. The chisel and mallet are employed to reduce the excessive bony labial plates. To insure that every chip of bone is recovered and to shorten the time of the procedure, a piece of gauze is placed at the bottom of the flap. The gauze also protects the soft tissue from instrument trauma.

The teeth are now removed. Each tooth and socket is examined carefully for tips, bone spicules, and apical pathology. After all teeth have been removed, the palatal tissue may be reflected about one-eighth of an inch to the lingual to avoid trauma and expedite suturing. The ridge may now be more finely contoured and smoothed with the rongeur forceps and bone file. Great care should be taken while correcting the cuspid area, for it is here that failure is most often encountered during preparation for the immediate insertion of the restoration.

The lingual side is contoured very little unless there is to be a reduction in the vertical height of the ridge. To determine if the desired amount of bone has been removed, the tissue flaps are approximated and the surgical tray is seated. Any high points of bone yet remaining will cause the tissue directly over it to blanch as pressure from the tray is brought to bear upon the area. These high spots can be removed easily with a bone file. The procedure with the tray is repeated until all prominent places have been eliminated.

The area may then be irrigated with saline solution and carefully checked for bone fragments. The tissue may be held in position and the denture seated. It is checked for retention and pressure on any certain area. If the seating is satisfactory, the tissues are ready for suturing.

There was a time when the dentist did his extractions for full dentures with one thought uppermost in mind—to extract teeth without leaving root tips behind. As was stated earlier in this paper, deep undercuts, sharp protuberances, and ragged edges were ignored because it was believed that they would heal and resorb in the time which lapsed before dentures were constructed, this being from three to six months. Now we realize that a much shorter time lapse for healing is all that is necessary. We also know that severe undercuts and most sharp, spinous projections will not correct themselves for years, if ever.

It should be noted, however, that at the present time some exodontists lean too far in the opposite direction and remove entirely too much of the alveolar process to provide ample room for the artificial teeth. By this procedure the patient is often deprived of his most valuable asset—the firm and healthy denture-bearing foundation.

Excessive surgery will usually result in loss of facial contour and a change in facial expression which will make the patient appear older than his years. The prime purpose of surgery in preparation for full dentures should be to conserve as much of the alveolar structures as possible and to remove only those tissues which must unavoidably be sacrificed under the conditions present.

Many times, although the extractions and bone correction are accomplished in an acceptable manner, the surfaces presenting themselves for full denture construction are unsatisfactory because of some abnormality of the soft tissue. This may be due to an abnormally high muscle attachment, failure of the operator to correctly approximate the buccal or labial mucosa to the lingual mucosa, the leaving of excess amounts of soft tissue after removal of large amounts of bone, or improper suturing. Generally we would expect the dentist who exercises good surgical judgment in

the removal of teeth and ridge-trimming to be proficient also in the handling of the soft tissues, but this does not necessarily follow. Abnormal soft tissue conditions might also be due to excess absorption of the ridges, or scar tissue, following an injury or burn, or to abnormal healing.

Excess soft tissue, the "flabby" ridge, is frequently seen in the patient who has worn ill-fitting dentures and is thought to be due to trauma. It occurs most frequently on the anterior portion of the maxillary ridge due to occlusal stress. This is hypertrophied tissue which may or may not be inflamed. It may be quite soft or rather fibrous, but it is always loosely attached and is often sensitive to the touch.

The removal of soft flabby tissue is accomplished by making incisions bucally and lingually to the tissue to be excised, the incisions meeting mesially and distally to the tissue in question. These incisions are deepened to the bone in such a manner that an elliptical shaped mass is removed. By this method the underlying soft tissue is removed in such a manner that the edges of the flaps will approximate each other over the ridge. Any excessive length of the flaps is trimmed and the ends are sutured.

When the base of the soft tissue is very narrow it may be trimmed off with tissue scissors and the edges undermined to allow close approximation for suturing.

Frequently, low hanging maxillary tuberosities offer interference in the construction of dentures. This tissue is usually a mass of fibrous tissue due to hypertrophy resulting from trauma or improper surgical technique at the time of extraction. Superficial excision of the excess tissue is valueless since a mass of scar tissue will form which is practically as harmful as the original mass. This operation would be performed in a manner similar to the correction of the "flabby" ridge. Incisions are made so that a triangular section of tissue may be removed. The buccal and lingual edges of the flap are then approximated, trimmed, if necessary, and sutured.

The problem of abnormally high muscle attachments on the edentulous ridge and the management thereof is one open to considerable controversy. Miller[17] states that he cannot recall one single case where a low muscle or tissue attachment presented such difficulties as to absolutely necessitate their surgical displacement. While this statement may be true, there are certainly many cases where the surgical displacement of abnormal muscle attachments will serve to make the denture construction easier and also result in a better functioning denture.

It is the opinion of the writer that many prosthodontists have found that a full denture cannot always be correctly and successfully made under the aforementioned circumstances. Either the adhesion of the denture is lost or it causes great discomfort to the patient by irritation to the frenum. Since the operation is simple and seldom fails to give satisfactory results, it should be performed under these extreme conditions of muscle attachment. The large labial frenum may come under the same category as that mentioned above. Operation for such may be done as follows:

If local anesthesia is to be used, infiltration should be given just lateral to the frenum on both sides, using only a few drops to avoid distortion. An injection

should also be made into the anterior palatine foramen. Complete anesthesia should be obtained in about one and one-half minutes. Grasp the upper lip with the thumb and forefinger of one hand and raise the lip. With the lip extended a large hemostat is applied and locked into the frenum with the beaks extending the full length of the muscle to the depth of the cul-de-sac. The hemostat is then dissected out of the tissue by incising the tissue on each side immediately against the beaks. This will free the hemostat and also the frenum which remains in the grasp of the hemostat. The raw edges are then sutured together to prevent strain on these surfaces. Sutures are removed on the fourth day.

Correction of abnormal muscle attachments in the bicuspid region, which are frequently troublesome in either or both arches, may be done in the following manner:

Obtain good anesthesia. A curved incision is made on the buccal aspect of the alveolar process starting at about the region of the mesial of the first molar. This incision is made down to but not through the periosteum. The incision is carried forward to about the cuspid region with its convexity directed in the direction of the crest of the ridge. This will necessarily pass above or below the muscle attachment in question. The submucosa is separated from the periosteum by the use of a periosteal elevator. This tissue is relaxed to the depth of a normal cul-de-sac, thereby freeing the muscle attachment, and sutured in this new position. The free edges of the flap are sutured open, the sutures passing deep into the submucosa. Some sort of surgical sedative dressing may be applied to the denuded area for the comfort of the patient—this is not necessary.

Practically every dentist is confronted with the problem of construction of full dentures for the patient who is devoid, or practically so, of a mandibular ridge. It is extremely difficult, if not impossible, to attain any satisfaction of function in these cases. Certainly every case that does not present a good mandibular ridge should not be submitted to surgery. Many authors, however, state that in most instances and in certain selected cases the response is gratifying.

In order to give more height to the ridge, operations similar to the curved incision method of displacing buccal muscle attachments are used in which various methods are employed to prevent healing of the tissues in the original position, thus adding depth to the fold. Surgical dressing as mentioned before may be used to this advantage. The electro-surgery knife is also used in this attempt on the grounds that cauterization of the raw ends of the tissues reduces cicatrization to a minimum, therefore preventing obliteration of the newly formed sulcus. The final results of these methods have been only partially satisfactory and, in some instances, wholly unsuccessful in that adequate provision is not made against reunion of the raw surfaces. The following two methods have reportedly been more successful.

The inlay skin graft method is done under bilateral mandibular block anesthesia. A sulcus of sufficient depth to assure retention of the denture is created along the base of the remnant ridge. This is accomplished by incising the buccal alveolar mucosa from one molar area to the other. Incise through the mucosa and submucosa down close to the periosteum, taking care not to injure that structure.

After bleeding has been controlled by pressure, a piece of softened stent is pressed into the cavity and molded by finger pressure on the overlying cheek. It is held in place until hardened and lifted out. This stent is of sufficient size to fill the sulcus without causing more than slight tension when the suturing is done over it. After removing the stent a gauze pack is placed to further assure hemostasis which must be absolute if the graft is to take.

From a selected area on the thigh or forearm, previously cleaned with soap and water, alcohol, and ether, a thin razor section is cut. This skin is wrapped around the stent with the raw surface out, the edges just meeting after enveloping the stent once. The gauze pack is removed from the sulcus and the graft covered mold is inserted. The mucosa is sutured over the mold under only slight tension.

The success or failure of a graft is due largely to immobilization of the area. Therefore, a splint is previously constructed of upper and lower acrylic trays connected in bite relation with the opening for passage of food. The mandible is rendered immobile by head bandages which are left on seven days. On the eighth day bandages are removed and the sutures cut and the stent removed, leaving a skin-lined cavity. The above given technique is seldom used for two reasons, one being the high mortality of the graft, and the other being the great difficulty and discomfort to the patient.

There is another operation, advocated by many authors, in which the techniques are not so exacting nor the discomfort to the patient so great.

A horizontal surface incision is made about one and one-half centimeters lateral to the crest of the ridge in the cheek and/or lip. With a sharp instrument the mucous membrane is separated from the underlying tissue toward the center of the ridge. The tissue lateral to the incision is dissected out as far as necessary without disturbing the periosteum and folded under the free mucous membrane on the ridge. The membrane is extended over the exposed periosteum and sutured. The proximal edges of the denuded area are brought down to the newly formed groove and sutured. Sutures may, if desired, be passed through the cheek to the outside. The sutures through the skin are removed in four days, and those in the mouth in six or seven.

It may be said without fear of contradiction that the principal objective concerning surgery of the alveolar ridge is the eradication of pathologic and otherwise abnormal conditions which would greatly compensate the patient for the time, pain, and discomfort endured.

REFERENCES

1. Eckardt, W. L.: Surgical Preparation of the Mouth for Artificial Dentures., J. Mo. State Dent. Assoc. **20:** 156-159, 1940.
2. Hayes, L. V.: Alveolectomy, Dent. Items of Interest **57:** 500, 1935.
3. Ralston, R. R.: Alveolectomy, J.A.D.A. **15:** 896-900, 1929.
4. Suddarth, C. S.: Surgical Preparation of the Mouth for the Reception of Artificial Dentures, J.A.D.A. **23:** 468-473, 1936.
5. Molt, F. F.: Preparation of the Ridges for Fixed and Removable Restorations., Dental Cosmos **25:** 21-27, 1938.
6. Discussion on Alveolar Absorption (Trimming of Process Following Extractions)., Dental Register, 1872, pp. 475-476.

7. Young, D. H.: The Treatment of Prominent Alveolar Process, Dental Cosmos, p. 271, Mar., 1908.
8. Potts, H. A.: A New Operating Procedure Facilitating the Adaptation of Artificial Dentures., J.A.M.A., pp. 188-189, Jan. 20, 1917.
9. Ruyl, J P.: Restoration of Abnormal Mouths by Surgical Treatment Before Inserting plates, Dental Cosmos, pp. 414-417, May, 1918.
10. Wald, A.: An Operation for the Reduction of Abnormal Formations of the Alveolar Process, Dental Digest, pp. 65-71, Feb., 1919.
11. Chernoff, P. M.: Corrective Surgery of the Jaws, Dental Digest, **52:** 83-88, 1946.
12. Cook, M. H.: Removal of the Anterior Maxillary Alveolar Process from First Bicuspid., J.A.D.A. **30:** 43-44, Jan. 1, 1943.
13. Potts, H. A.: Conservation Versus Destruction., J.A.D.A. **14:** 523-525, Mar., 1927.
14. Smedley, V. C.: Increasing the Possible Denture Foundation Area by Surgical Means., J.A.D.A., **28:** 1616-1623, 1941.
15. Dingman, R. O., and Hayward, J. R.: Oral Surgery in General Practice, J.A.D.A., **35:** 607-626, 1947.
16. Templeton, L. C.: Surgical Preparation of the Mouth for Full Dentures., Am. J. Orthodontics **31:** 517-518, 1945.
17. Miller, S. C.: Oral Diagnosis and Treatment., ed. 2, Philadelphia, 1949, The Blakiston Co., pp. 487-488.

Additional References

Berger, A.: Principles and Technique of Oral Surgery, ed. 9, Brooklyn, 1946, Dental Items of Interest Publishing Company, pp. 271-278.
Blair, V. P., and Ivy, R. H.: Essentials of Oral Surgery, ed. 3, St. Louis, 1944, C. V. Mosby Co., pp. 288-291.
Bourgoyne, J. R.: Surgery of the Mouth and Jaws, Brooklyn, 1949, Dental Items of Interest Publishing Co., pp. 181-186.
Dittmer, C. K.: Surgical Preparation of the Mouth for Immediate Dentures, Dent. Items Interest, pp. 1738-1740, Apr., 1937.
Droba, H.: Surgical Preparation of the Mouth for Full Dentures, J.A.D.A., **24:** 1687-1693, 1934.
Everson, S.: Postextraction Alveolectomy and Alveolectomy for Immediate Dentures, Dental Digest **54:** 503-505, 1948.
Feldman, M. H.: Surgical Correction of Alveolar Ridge Irregularities as an Aid to Denture Stability, Dental Digest pp. 46-48, Feb., 1932.
Gerosso, S. F.: Surgical Resection of Muscle Attachment of an Edentulous Mandible, Am. J. Orthodontics & Oral Surg. **25:** 590-591, 1939.
Gorney, H. S., Gerney, A. J. and Fomon, S.: Creation of a Mandibular Ridge by Deepening the Labial Sulcus and Lining It with a Skin Graft, J.A.D.A. **29:** 751-754, 1942.
Landa, J. S.: Practical Full Denture Prosthesis, Dental Items of Interest, pp. 977-983, Oct., 1943.
Lillie, J. L.: Removal of the Anterior Maxillary Alveolar Process from Second Bicuspid, J.A.D.A., **28:** 858-859, 1941.
Mead, S. V.: Oral Surgery, ed. 3, St. Louis, 1946, The C. V. Mosby Co., pp. 645-691.
Miller, H. C.: Mouth Preparation for Dentures, Ill. State Dent. J. **9:** 244, 1940.
Molt, F. F.: Mouth Preparation for the Reception of Dentures, J.A.D.A. **14:** 506-515, 1927.
Pearce, J. H.: The Immediate Denture is Associated, The Fortnightly Review, pp. 7-11, Nov., 1944.
Potts, H. A.: Conservation Versus Destruction, J.A.D.A. **14:** 523-525, 1927.
Rosen, M. M.: Surgical Preparation for Dentures, Dental Outlook, **25:** 345, 1938.
Salman, Irving: Indications for Surgical Preparation of the Mouth for Prosthetic Restorations, Dental Items of Interest, **2:** 213-214, 1944.
Schies, M.: Surgical Preparation of the Maxillae for Full Dentures, Dental Items of Interest, pp. 3-13, Apr., 1937.
Templeton, L. C.: Surgical Preparation of the Mouth for Artificial Restoration, Tenn. State Dent. J. **27:** 3-11, 1947.
Zametkin, J. M.: Surgical Preparation of the Arches for a Full Denture, Dental Cosmos, pp. 381-385, Apr., 1927.

1405-6 Sterick Bldg.
Memphis, Tenn.

CLEFT PALATE RESTORATION: AN INTERPRETATION OF THE FITZ-GIBBON TECHNIQUE

GAYLORD J. JAMES, D.D.S.

Cleveland, Ohio

AS a group, cleft palate patients suffer from three deficiencies, any one of which would profoundly affect psychosocial adjustments. These are mastication, speech, and appearance.

In the congenital type of cleft palate, feeding is immediately a problem for the individual from birth onward; later, speech is a dominant factor. In his daily routine the mirror reflects to him the image he is forced to recognize as himself, so adversely different from his fellows. His burden does not stop with these three circumstances for, in addition, he finds himself unwanted in the world or, more particularly, within the family. He senses pity from those closely related to him, but, more pointedly, he frequently does not know love as such, and, still more often, senses repressed resentment on the part of brothers and sisters.

Often he is alone; sometimes parents have separated because of placing blame on a particular family line due to the presence of the deformity in other relatives. The cleft palate patient's lot is admittedly an unhappy one and his lifelong question which none can answer is, "Why did this happen to me?"

All of the above circumstances take on different complexions in individual cases. Sometimes such a person is unduly sheltered. His development is introverted. If so, he shuns social contact, and is entirely protected economically by composite family income.

Cleft palate is definitely among the catastrophic type of defects. Beginning at birth, the life of the person with a cleft palate may be one round of specialized treatment. It starts with surgical operations on the lip shortly after birth, closure of the palate as the growth pattern develops, orthodontic treatment at a later date, and prosthetic treatment as soon as practical, concluding with speech therapy until the ultimate correction has been achieved. Not always is it ideal to place speech therapy last, since, in the interim between some of these periods of specialized treatment, it is possible to continue speech therapy to a definite advantage in many ways.

Contemporary interest in the subject of cleft palate rehabilitation is most gratifying. This is a good omen because, as a group, these patients have been forgotten in a world concerned with polio, heart disease, and cancer. While its occurrence is not as prevalent as any of these, its effects are fully as severe in heartache, dehabilitation, embarrassment, and psychologic repercussions. The re-

Read before the Academy of Denture Prosthetics, Milwaukee, Wis., May 4, 1950.
Received for publication, Dec. 22, 1950.

pair of these defects and the restitution of these patients to a normal position in society is worthy of the profession's best effort. The dentist is an important part of the chain of specialists who must deal with the rehabilitation, if the result is to be as satisfying as is desirable.

The profession of dentistry has developed many skills for the benefit and comfort of mankind. The general practitioner must accept the responsibility for the care and hygiene of the mouth in these patients from an early age. The orthodontist must aid by regulating the dental arches, and by encouraging the proper erupting and positioning of such teeth as may be available or present. The prosthetist must not only protect the orthodontic result with his efforts, but must correct deficient esthetics, and rebuild, or construct entirely, a masticatory apparatus efficient enough to maintain existence. In addition, but by no means a lesser consideration, he must understand speech problems thoroughly, and construct an obturator capable of manipulation by the patient, to the degree of speech perfection desired by that patient. The prosthetist, therefore, bears a considerable burden of dentistry's share in cleft palate rehabilitation. It is to him, and his problem, that we are devoting our efforts in this paper.

The work of the prosthetist supplements the surgeon's skill; we are frequently asked if surgery is desirable, and our answer of necessity will always be in the affirmative. This is for the simple reason that a good surgical result, while not a complete correction of the defect, would at least allow the patient to wear a lighter appliance. Therefore less strain would be put upon the vital structures of the maxilla, which are so important to this group of people.

It is quite probable that the first use of prosthetic devices occurred after a marked surgical failure. During the nineteenth century, and in the early part of our own, the prosthetist labored under the severe handicap of not having materials and methods that could help him adequately in his work of restoration. Today, however, the situation is much different because of the new approaches that have been made to the problem of restorative work in general. We can adapt all of these approaches and all of the new materials to the benefit of our specialty work in cleft palate prosthesis.

Many are familiar with early attempts in the prosthetic field to satisfy this need. This history is a matter of record and, therefore, need not be repeated by me in detail. Ambroise Paré, in 1541, published a description of an obturator. While his materials were limited, he had discovered a method of stopping a hole, and thus facilitated speech to some degree. He used a spongy material which became larger as it absorbed the secretions of the mouth. Other contributors in this field include Pierre Fauchard, Etienne Bourdet, Christopher Delabarre, and Snell. Many of these used India rubber which was sticky and quite perishable. Kingsley is given credit for developing a definite technique. He had at his command at that time a new material—soft, vulcanizable rubber. It was an appliance with a prescribed technique of construction, for all types of cases, and it did function well when made properly. It was subject to criticism because it was porous and absorbed the fluids of the mouth. It was unsanitary and dangerous to the health of the

individual who was forced to wear it. The deficiency of materials did not stop attempts to improve design and method, however. In this regard, the twentieth century will always be remembered for such names as Calvin Case, and Kazanjian, (who worked with a maxillofacial team in France during World War I), Mitchell, (who advocated a hinged appliance and included an artificial vomer), Olinger, Ottolengui, Young, and Fitz-Gibbon.

I believe that I can say without contradiction that the foremost authority in the prosthetic correction of the cleft palate deformity was Dr. John J. Fitz-Gibbon of Holyoke, Mass. Dr. Fitz-Gibbon had been afflicted with this abnormality himself since birth. He, therefore, experienced firsthand all of the unpleasant situations that can come to a sensitive person as the result of such a handicap. When he became a dentist, it was natural that he should turn to the literature for information regarding obturators when surgery had yielded a disappointing result. The review of the early materials used for this purpose was naturally disappointing to him, since he had to make an appliance which would satisfy himself from the standpoint of actual use. He, therefore, turned to gold as being ideal. Its cleanliness, its tolerance by sensitive tissues, and its lack of absorption to cause unpleasant mouth odors and tastes appealed to him. It needed only to be made sufficiently light in weight to be worn comfortably. Consequently, he fashioned his first appliance from swaged stock with wrought clasps, a swaged bulb and solder joints. Crude as the appliance was, when compared with others that came later, it was nevertheless an original step in another direction. With the development of the one-piece casting, the spring clasp, the bar clasp, and better materials with which to work, he improved his appliance continually until it had reached a stage of perfection that satisfied his inquisitive nature.

As the years advanced, his thought, his effort, most of his time, and his charity was spent in developing knowledge regarding this deformity, and the rehabilitation of those afflicted with it. During his lifetime he carried on alone, clinicing, lecturing, and writing, thus contributing much material to this study. I believe that he fully intended to leave us a composite record of his work so that it could be carried on from that point. Unfortunately, when he died two years ago, this had not yet been accomplished.

Many of the contemporary authorities in this field, however, have felt the influence of his experience, and are carrying on the work which he so nobly started. At the time of his death the plastics were already established in prosthetic dentistry, yet he did not use plastic bulbs and plastic bodies for his appliances. In all the time that I spent in his office, I saw only one such appliance and that was made as a speech-training device for a child. I do not feel that there need be any controversy over the choice of materials because (if I interpret his reactions correctly) he felt that the all-metal appliance, with plastic veneers, teeth, and plumpers was probably the best combination of our contemporary materials. Since he was wearing such an appliance himself, and since he had experimented upon himself with all other types of materials, including the plastics and chrome metals, I feel that his decision in this matter should suffice. Many of these all-metal obturators are

just as light as the average removable bridge. The weight in many instances is a factor to consider, particularly in the larger cases. The technique for their fabrication is complicated. Speaking frankly about philanthropic efforts, the expense of supplying such instruments to the public at large would be prohibitive. For example, four years ago I was visited by a dentist from Oslo, Norway, who was attempting at that time to ascertain what was being done in this country for the cleft palate deformed individual. When he saw some of the work we were doing, his immediate observation was that it could not be afforded in his country because medicine in his country was on a social basis and that such appliances would definitely be prohibitive from the standpoint of expense.

I believe that if Dr. Fitz-Gibbon were here today he probably would have carried on as he practiced throughout his lifetime. But I know, too, that as new materials were developed or new methods of handling old materials were improved, he would have incorporated them in his appliances, and probably would have been among the first to advocate a change if that change materially benefited those individuals who must wear these products of our handicraft.

The Fitz-Gibbon classification for cleft palate deformity is relatively simple. It would be fine if we could accept such a standard nomenclature, for then our discussions would take on more meaning for all. It is as follows:

Type 1.—A cleft of the soft palate only.

Type 2.—A cleft of the soft palate and the hard palate.

Type 3.—A cleft of the soft palate, the hard palate, and a unilateral extension on one side of the premaxilla, erupting on the lip as a unilateral harelip, sometimes extending up into the nostril for varying distances. (Usually these are on the left side.)

Type 4.—A cleft of the soft palate, the hard palate, and the bilateral extension through both sides of the premaxilla, leaving it as an island attached to the base of the septum, sometimes with only a small spicule of bone, and a bilateral harelip extending up both sides of the nostril.

Further description of these four basic types by the words *congenital, acquired, postoperative, and edentulous* gives us a picture of the conditions which might exist in a given case. The design of his appliances was as applicable to one type of case as another, irrespective of the fact that they were congenital, acquired, postoperative, or edentulous.

Nature, in her abnormalities, does not conform to definite patterns of development as she does in normal situations. It is, therefore, apparent that one problem will resemble another in two or three important considerations, but will require still another application in respect to other factors. In the more complicated obturators, one will find similarities of importance.

DIAGNOSIS

Probably cleft palate prosthesis, when considered as an entirety, demands more of the individual than any other branch of dentistry. Every phase of dentistry must be considered diagnostically in order to render the most help to the patient

in each instance. A series of steps has been provided for our guidance. Each and every case should be so carefully considered.

1. Diagnostic findings should be recorded on history sheet so that we will have a permanent record for future use. The first step consists of gathering as much history concerning the case as possible. This includes information regarding other instances of cleft palate deformity within the family, the type of cleft, its present status as to whether congenital, postoperative, acquired, or edentulous, the age of the patient, his general health, the number of operations undergone, and some analysis of the family's station in respect to society as a whole.

2. A clinical examination of the teeth present and of the periodontal tissues, particularly in the upper arch. This would be a comprehensive dental examination to be later supplemented with full-mouth roentgenograms. At this time, a general observation should be made as to the condition of the bite, as to whether or not there is abnormal closure, and whether or not the vertical dimension should be changed to improve esthetics and increase the vault volume itself. This may facilitate tongue manipulation in speech and comfort in rest position as well as aid in the function of mastication.

3. The next observation should be of the cleft, its width, its dimensions, and the amount of flexibility of soft palate remnants upon swallowing. Most of these patients have no difficulty in swallowing with their mouths wide open; the posterior constrictor muscles move toward the midline when this is accomplished. Their angle of approach is most important because it has a bearing upon the shape of the bulb which will eventually extend into the pharyngeal space in the vicinity of Passavant's cushion. The planes of the bulb will be regulated by this angle of approach; therefore, some picture of these mechanics in the operator's mind is most important.

4. If the problem under consideration is one of postoperative failure, the amount of bone present in the hard palate, the amount of coverage needed, and all perforations of the same should be noted because the design will be materially affected by the presence of these conditions.

5. Passavant's cushion should be palpated with the finger. I usually use the third finger of my right hand to feel its prominence. The cushion can be noted readily, as a pronounced, rounded, hard protuberance from the smoothness of the tissue itself, when the finger is passed over the surface of the posterior wall of the pharynx. This is marked with an indelible pencil so that its location in relation to the soft palate remnants can be appraised. It is wise to locate it each time so that in the various operative procedures concerning this area it is at once apparent, because the future tailpiece needs to approach this as directly as possible, or at least near enough so that the bulb will not be of undue dimension.

6. A good study cast should be made of the case. This is done by taking an impression in compound. A properly fitting stock tray is selected, and then extended into the pharyngeal space, with Kerr's utility wax or with a sufficient amount of compound supported on the first two fingers of the hand. As it hardens, it is pushed against the pharyngeal wall so as to record the relationship of all structures in that area even though they are compressed. Care must be used that

the compound is not allowed to get too hard before removal. The removal of the impression is started, the impression is replaced to position, it is then started a little further and replaced, and finally, pulled all the way out. We admit to some distortion of undercuts and other structures in the study cast because of taking the impression in this manner. But the method of removal assures us that the tooth negative will be reasonably good for us to study conditions on a cast. Another impression is made of the lower dental arch, and a correct bite is taken to show the true relationship for mounting the cast. The upper impression is poured in plaster or stone. A quick biteplate is made of shellac-base material, approximating the teeth as closely as possible and having sufficient extension to simulate the curtain of the soft palate. This extends down over whatever remnants of the soft palate that may exist. It is then carried back to the mouth for a quick correction to the position of these remnants in repose. When this is replaced on the cast, it shows the amount of compression that took place at the time the impression was taken. All of these structures can be elevated to the proper height with a brush and soft plaster, thus giving a reproduction of the true conditions that exist in the mouth. This is not a working cast by any means. It is meant only for the purpose of visualizing the case to the operator.

7. By using the cast and checking at the mouth, it is now possible to study in detail several conditions:

Notice the cuspid and first bicuspid relationship. This may be important. Molar relationship may have to be disregarded because of other conditions. Study possibilities of grinding the occlusion in relation to the esthetics of the case as a whole.

Many cases present and underdeveloped maxilla and a normal mandible. This condition causes a prognathism which is not desirable in the finished case but which must be treated as part of the case if lasting satisfaction and esthetic success is to be achieved. The answers to the following questions may help to solve this problem:

Can orthodontia be of any help in this case? Is mutilation necessary?

Is tooth contour favorable? What are the possibilities of clasp retention and design, in terms of lost contacts and making of necessary preparations to break contacts for embrasure arms and hooks?

Can existing teeth in the anterior part of the mouth be helped with jacket preparations or veneer castings which will restore appearance, or at least a percentage of normal relationship?

What is the bite relationship? Is it closed or open? Is it necessary to change this for the success of the case?

8. Explore and investigate fissures in the palate to determine, in postoperative cases, whether or not surgical closure of various structures has been successfully accomplished. A flexible blunt probe not too large in diameter will be found helpful in making this exploration. Use of a mouth lamp with cold light facilitates this procedure. Since a tissue seal is sufficient, this may be accomplished with a flap of tissue covering the area adequately. Design is immediately affected by this inves-

tigation, and the decision must be made to surround these areas with the appliance or to use it to accomplish the desired seal.

9. Determine whether the case will be tooth-borne or tissue-borne, and whether or not there will need to be full palatal coverage.

10. Notice the relation of structures to each other. Palpate for hard areas, and carefully analyze areas that may be encroached upon later for cast correction.

11. X-ray diagnosis is of great importance to check upon pulpless teeth, roots, and impactions, as well as carious areas. A word might be said about pulpless teeth in this regard. While we do not wish to break any of the rules of dental health as they apply to any patient, we still can not accept an arbitrary point of view which considers the extraction of all pulpless teeth for these patients, whether there is definite demonstration of infection present or not. A pulpless tooth may be of great importance to this patient in aiding him to retain his appliance for many years. Also, teeth that are extremely carious, but straight-rooted, may be so treated if the retention of the appliance will be facilitated by their remaining in situ. Unless the individual operating is adept at this type of treatment, I believe the patient should be referred always to an endodontist for any such procedures. It is important and should be given the best possibility for success.

12. All carious areas and hard surface reconstruction such as fixed bridges, jackets, overlays, onlays, etc., should be planned for and accomplished before the major restoration by the appliance is started. It is not always desirable to attach such constructions to the appliance itself, particularly if the anterior prosthetic problem can be satisfied with fixed work. However, in many cases it is impossible to do otherwise, and all of the replacements must be attached to the appliance.

13. Unerupted teeth may be helped into position or they can be exposed by dissection to a point that would facilitate the rest area, which might be of service. In younger patients these teeth sometimes have an opportunity for erupting further if so treated. Therefore, this consideration must not be overlooked in diagnosing the case.

14. The lower mouth should be adequately taken care of so that occlusal relationship will be proper upon the insertion of the appliance. This would apply particularly to those cases which have replacements attached to the appliance. From all points of view it is important that the entire mouth be in first-class condition of dental health. This means that any replacements that may be necessary are completed sometimes during the series of treatments.

15. The problem is the proper retention of the denture base in edentulous cases. To yield the best result, one must have the best of mouth preparation (cover on the box type). Other retention points by means of wings, buttons, etc., should be carefully considered as to their possibility for use, and the angle of insertion determined.

The foregoing steps will materially aid the operator in determining his procedure and treatment plan of the given case. It is true that all cases are not complicated, but it is well to have a precise method of procedure in order that the routine of treatment be systematized to yield a more predictable satisfactory result.

TECHNIQUE

We are now about to examine the steps of the related technique which are basically the same for all cases, except where deviations are necessary to satisfy certain conditions. The patient who was selected for this series of steps was one of the more complicated types: Type 4 postoperative, with the additional problem of the excision of the premaxilla.

Fig. 1 shows this patient at the age of 15 following surgery, at a much earlier age, which had been very unsuccessful. At this time the scar tissue was removed from the two incisions, and the lip and the vermilion line were more satisfactorily joined. The first of several operations on the nose was accomplished, to be completed several years later at which time the patient became a patient in our office.

A. *B.*

Fig. 1. — *A*, Early full face. *B*, Early profile.

Fig. 2 shows the patient before our work was begun, but after the corrective surgery referred to above had been completed. At this time she was 22 years old. Several supernumerary teeth which existed in the cleft had been extracted, and the mouth had been placed in good dental repair. All carious areas were taken care of before starting the construction of the appliance itself. The normally developed lower jaw, the inhibited development on the part of the maxilla, plus the excision of the premaxilla gave the usual picture of increased prognathism present in such instances. This is adequately shown in the profile view, which emphasizes the deficiency referred to.

Fig. 3, showing the full face, may now be compared with the first illustration of the patient taken at the age of 15. A remaining scar is noticed near the left nostril, but this could be adequately handled with cover mark and powder blended to match the skin. The balance in the vermilion line was aided a little bit with lipstick. This was the patient's own effort. It is much to her credit that she tried to do what

she could to enhance her appearance. The squint may be the effect of the bright lights that we used in taking the pictures, but I am inclined to believe that it was natural at this point, because of lack of support for the base of the septum and the tissues in general, due to the excision of the premaxilla as previously described. This individual did not show much hope as evidenced by the expression on her face. It is true that she had been disappointed many times. It is also true that she had been unfortunate for, up to this time, she had not been able to get employment. What then could we give her to hold out hope for the future? This was also part of the sequence. At the conclusion, these illustrations should be compared with the eventual result.

Fig. 2. Fig. 3.

Fig. 2.—Profile before correction.

Fig. 3.—Full face before correction.

Proceeding now with the technique, the condition of the mouth before starting treatment was as follows: There was a missing bicuspid on the upper left, the third molars were in place, and because they were in occlusion we did not advocate their extraction. Generally, I like to dispose of third molars of this sort but I was anxious to retain everything that would help me support an appliance that was going to be as large as this.

When the mouth was open (Fig. 4), and upon looking into and toward the pharyngeal space, we noticed the remnant of the uvula and the presence of one of two perforations in the midline. The marked velar insufficiency in the posterior had caused a marked nasality. At this point we started treatment by creating an embrasure between the upper left first and second molars, and the upper right first

molar and the second bicuspid. The reason for doing this was for esthetic consideration, and to get groups of teeth into clasp combinations. I do not like to create an embrasure between single teeth because I feel that the strain is too great, and probably would lead to the loss of the tooth. But where there are good stable teeth, two or more in a group, there is a much better chance of success. Much of this can be determined by having the patient smile to see where the corners of the lips are going to strike, a fairly wide smile, and then try to keep the embrasure out of that view.

When the embrasures were prepared, two small combination clasps of the spring type were placed, which were worn by the patient to maintain the embrasure as it was at the time of preparation. The reason for this is apparent. If carried out this way, it means that the size of the embrasure will be constant, and will yield a better result when it comes time to fit the appliance in the mouth. Otherwise, the embrasure might close, and a further loss of tooth structure could be serious, since there is only a limited amount with which to prepare these spaces.

A cast was made from an impression taken in hydrocolloid immediately after preparing the embrasure spaces. Duplicate refractory casts were made on which we cast the clasps that are referred to above. This impression was carried up to the base of the septum on a compound base, which had been trimmed a little short of the cushion that had been created by the surgeon at that point, for the saucer-like crypt which the appliance will have made to support this area on completion. A shellac baseplate was carefully fitted around the lingual aspect of the teeth with an extension sufficient to allow it to be corrected in the mouth to the proper contour of the soft palate, when in repose, and to the proper length which, in this case, covered the remnant of the uvula. Posteriorly, it was sufficiently long to allow it to come within reasonable striking distance of Passavant's cushion with a bulb which was of fair size because of the marked velar insufficiency.

Fig. 5 shows the correction of the tailpiece in the mouth and the extension of it posteriorly to cover all perforations and some of the void in the pharyngeal region. After such mouth correction it was carried back to the original cast and the cast itself corrected for compression and dimension. At this time, the original cast is encroached upon in the posterior region if there is undue soft palate flabby tissue which may compress very easily, and thus allow the appliance to be in a different relationship than was planned. It must be in a stable relationship, otherwise it cannot be used as it was intended. Therefore, all changes were made on the cast and the cast was now duplicated.

The duplication was poured in a refractory investment. The casting was designed and waxed according to our conception of its needs. The design of this appliance was considered to be two separate appliances in one. From the embrasures forward, it was an appliance for esthetics. From the embrasures posteriorly, it was a speech appliance.

Fig. 6 shows the duplicated cast and waxed design before spruing. The casting was completed in the rough. Several reservoirs and vents were placed around on the margin of the casting to allow for the receiving of the molten gold, almost

Fig. 4.

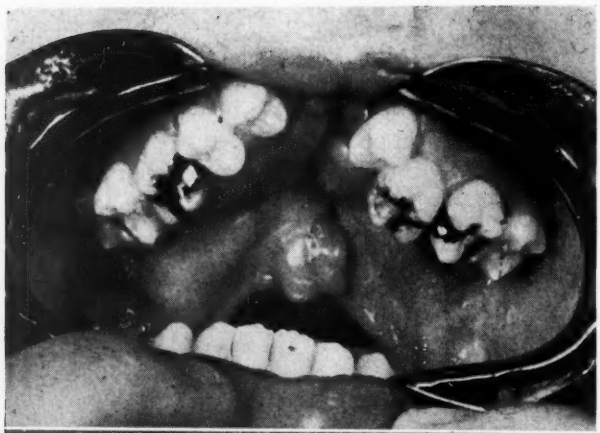


Fig. 5.

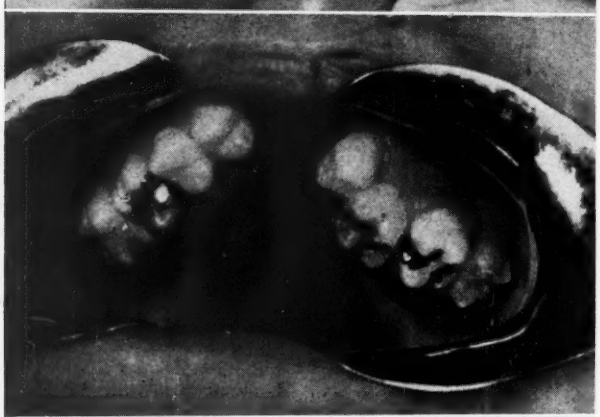


Fig. 6.

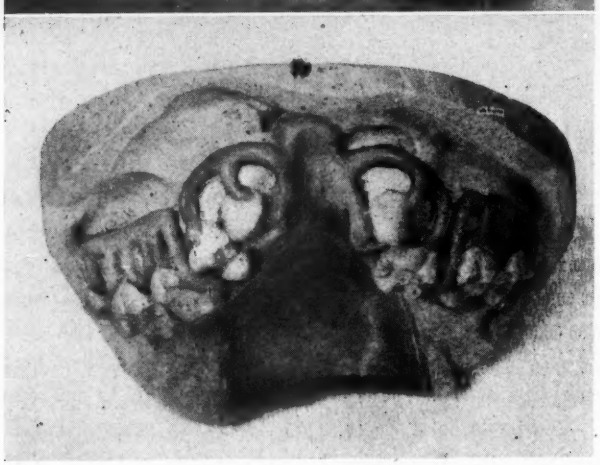
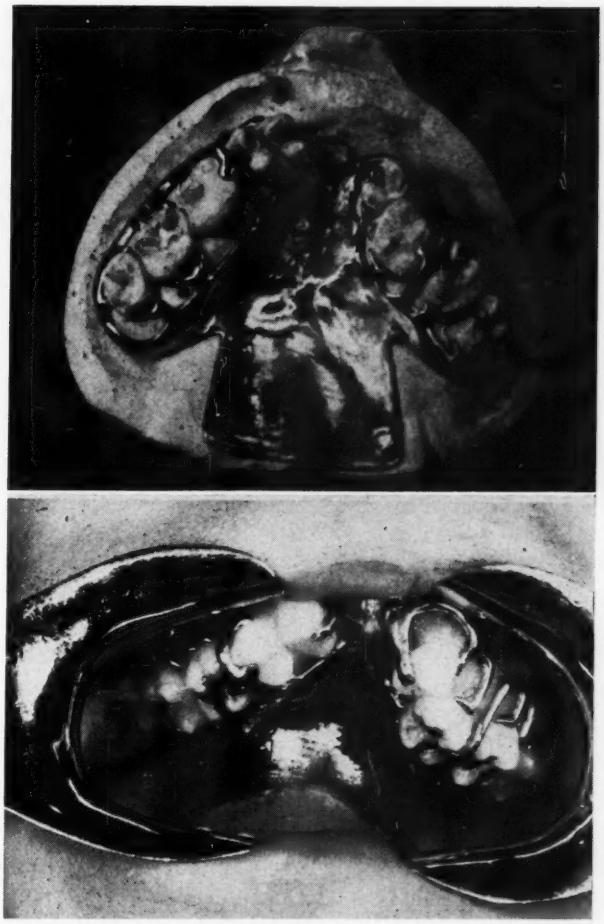


Fig. 4. — Open mouth starting treatment.

Fig. 5. — Tailpiece correction in mouth.

Fig. 6. — Waxed design.



A.

B.

Fig. 7. — *A*, Casting fitted on cast. *B*, Casting tried in mouth.

instantaneously, into the mold. This gives a nice dense casting because the vents allow for the escape of air and the reservoirs provide additional material so that porosity is definitely avoided. This casting was made from two and one-half ounces of gold, using about one-half of it in the original casting. The sprues and buttons were removed and the case polished in the rough.

The casting was surveyed for angle of insertion and with this type of attachment it was necessary to approximate the fit on the cast and then return it to the mouth for the final procedure. At this point someone will ask if I use a surveyor in these cases. A surveyor is satisfactory in some of the smaller cases, but in the larger cases I find that retention is such a delicate thing that you want all the retention you can possibly get. So, as Dr. Fitz-Gibbon used to tell me, I put on everything but the kitchen sink and take off what I have no use for.

The retention of the appliance in the mouth is illustrated in Fig. 7. This is to check the fitting of the attachments in proper position upon the teeth themselves.

The extension of the tailpiece in the back can be vaguely seen and we were gratified, at this point, that our base casting was fitting as we designed it.

After selecting the mold and shade of the teeth we aligned them as we wished them to look in the completed appliance. The esthetics were important to us, and so by means of wax supporting these teeth with more or less bulk, we carried them to the mouth. See Fig. 8. These teeth are porcelain. Acrylic teeth could have been used. That choice is at the discretion of the operator. Regardless of the choice of teeth, a duplex casting must be made for this type of case in order to sup-

Fig. 8.

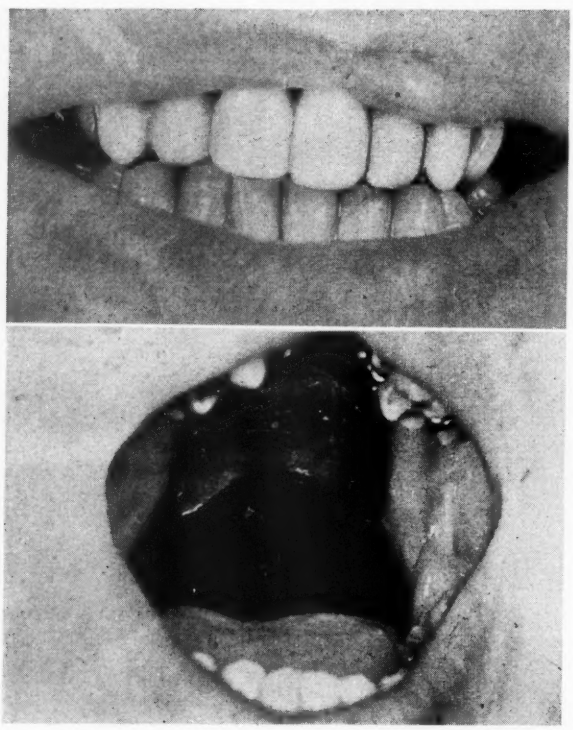


Fig. 9.

Fig. 8. — Arrangement of teeth.

Fig. 9. — Bulb impression.

port the teeth themselves. Therefore, the additional weight of porcelain as compared to acrylic would be almost inconsequential because the casting would have to provide for their attachment. Since the gingival portion of the tooth was not to be supported by gold, but rather by plastic, it was possible to reduce weight considerably by cutting the gold backing down within a third of its normal dimension, allowing the porcelain to extend up into the plastic material the rest of the distance.

The duplex casting was attached to the main body of the appliance using the rests and the palatal vault as a guide for its positioning.

We then turned to the problem of the speech factor; Fig. 9 shows a bulb impression being taken of the void in the pharyngeal area. Notice the width of this bulb and the width of the tailpiece. It is difficult to see the planes of angulation at which the constricting muscles slid over the bulb body. This can be seen to better advantage in Fig. 11. However, when this patient attempted to swallow, there was only a bare flicker of movement because so much multilation was in evidence. This accounts for the width of the bulb, and also the amount of velar insufficiency which exists.

Fig. 10.

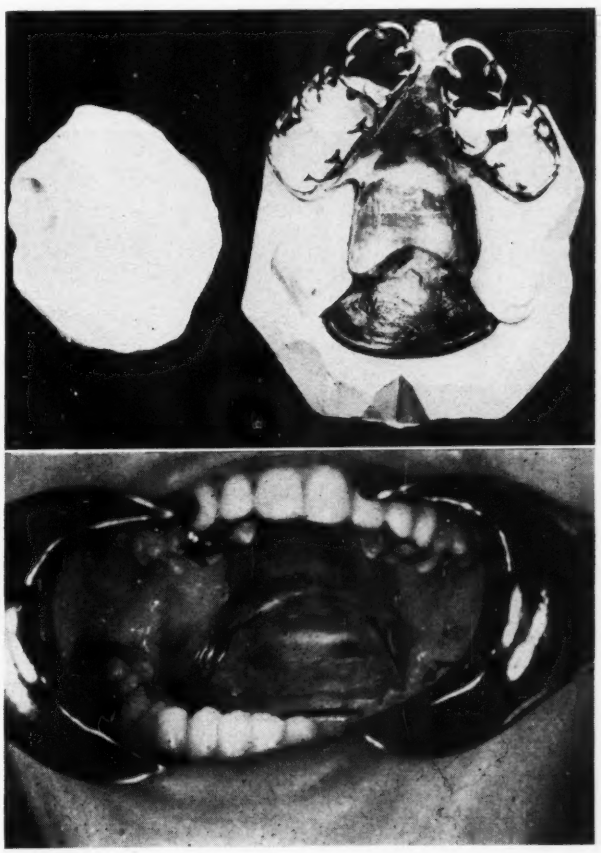


Fig. 11.

Fig. 10. — Mold of bulb impression.

Fig. 11. — Appliance in mouth.

Fig. 10 shows the bulb impression carried to a mold in which the relationship between the impression and the base appliance is achieved. This was done by embedding the posterior surfaces of the casting in the stone, while embedding the bulb in the rest of the stone; then by keying in the several parts. They were

all to be related and assembled together properly. This one happened to have four parts. This was because of existing undercuts.

It is often the custom to hollow heavy bulbs out to some extent on the lingual surface, making a concave surface. This allows space for the dorsum of the tongue to elevate, without too much inconvenience in deglutition. These molds were now coated with a good talcum powder, and assembled so that they were in a lower half and an upper half. These halves were then handled as follows: A piece of *22* gauge casting wax was forced into the various recesses in each half of the mold so that it conformed accurately to each part. It was then trimmed so that it had a very slight excess all along the periphery. The two halves were then brought into contact, laid on the surface of the bench, and hit a sharp hard blow with the fist, thus compressing the wax and joining the two together.

Fig. 12. — Lateral view of appliance in profile.

The top half of the mold was then removed and the excess trimmed away. Then the hollow wax bulb was lifted from the remaining parts of the mold. Grey investment was then flowed into the hollow portion of the wax mold, and a paper clip, which had been previously contoured to fit the open end, was slipped into this opening before the investment became hard. This acted as a stable support for the core so that when the casting process took place, it would not be dislodged. I am frank to admit that it might be necessary to make several such castings in order to get a correct one, without voids or porosity. The thickness of the casting, and the possibility of error is sufficient to cause a problem. But care, experience, and attention to detail will supply the need in most instances.

In spruing, try to balance the intake of gold to the mold in such a way that the volume of gold entering the mold will hit both sides of the core at the same time. Thus, the core is not so easily displaced as might be if all the gold entered from one side.

The gold bulb was polished and fitted back into the mold. The primary casting was fitted into position so that the tailpiece and the bulb joined each other as closely as possible so that, in the welding process, there would not be too much difficulty in closing the two together without a void. This was accomplished easily by using a slate pencil to push it in the direction indicated, before the solder reached flowing stage, and then the top was flash soldered. In other words, the soft mushy solder which went into the seam acted as a sort of dam because it cooled immediately, and the flash soldering of the surface sealed the joints. In this way the bulb was attached to the tailpiece as a hollow bulb. The case was then returned to the mouth and the teeth cemented in place, the amount of plastic was positioned under the lip to give the proper amount of build-out, and the plastic was cured.

Fig. 13. Fig. 14.

Fig. 13. — After-treatment profile.

Fig. 14. — After-treatment full face.

Fig. 11 shows the appliance in position and it is here that we can see the planes of the constrictors as they would move at an angle of approximately 45 degrees across the bulb. This is known as gripping the bulb in speech effort.

Fig. 12 shows the whole appliance in profile. This gives some idea of its length, some conception of the amount of anterior extension and a relationship to the muscles, because one can see the little channel created where the muscles ride the plane of the bulb as they pass over its body.

Fig. 13 shows a profile view of the finished result. It shows the amount of anterior extension which was necessary. In this case it needed to be as much as possible because of esthetic considerations.

Fig. 14 is full face. It shows the appliance in position with the patient smiling. When we compare Figs. 12 and 13 with Figs. 2 and 3, we immediately notice the psychologic effect upon the patient which has been achieved by the insertion of the appliance. Surely the reader will agree that hope has returned and expectancy of years of normal social contact is a definite possibility.

Fig. 15 shows a lateral view of the appliance in position and its relation to other anatomic structures as demonstrated by a cephalometric radiograph arranged by the Bolton Study (Western Reserve University School of Medicine).

There will perhaps be some adjustment to the appliance itself subsequent to the date of insertion if any of the parts rest upon soft tissue as shown in the anterior section of this appliance which I have just explained. However, these are easily taken care of, and while the constrictors are slightly irritated at first by the rubbing of the pillars against the bulb, it usually gives no trouble unless the tissues are overcompressed by the bulb or unless other parts of the appliance are not in harmonious relationship to the tissues.

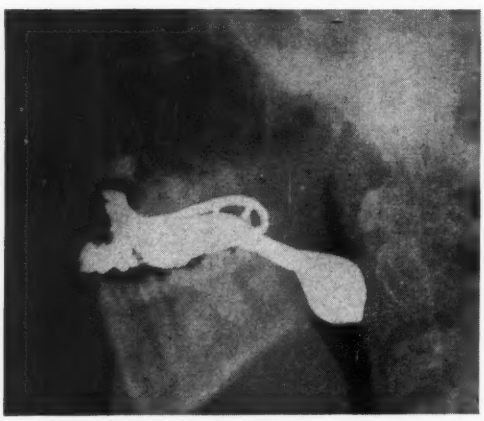


Fig. 15. — Cephalometric radiograph of appliance in situ.

CONCLUSION

In conclusion, something should be said about the ability of the patient to wear and to speak with such an appliance as we have fabricated. Perhaps a great deal of the success which Dr. Fitz-Gibbon achieved, his genius in handling this kind of case, might be due to the fact that he not only understood the patient but that he understood their speaking problems as well. Fitz-Gibbon[1] said, "The surgeon visualizes only a perfect operation, a closed palate. Although this is greatly to be desired, it does not follow that a perfect union of the parts will restore normal function to the palate. The method of producing normal speech with an appliance is entirely different than that employed with a normal palate. The basic principle of the heretofore accepted appliances has been to produce tone as a normal person does with a normal palate. This simulation of normal

palate action, difficult, if not impossible of attainment, can be disregarded and normal speech produced by the voluntary constriction of the pharyngeal palatine arch on the bulb of the Fitz-Gibbon appliance. An action in producing the palatine consonants, particularly the sonants, is horizontal instead of vertical and involves the gripping of the bulb as in the act of swallowing. Once the individual acquires the gripping, swallowing action, the production of normal sounds is greatly facilitated."

The work of the prosthodontist can be greatly helped by taking advantage of another group of specialists known as speech correctionists. These persons have made a detailed study of the various abnormalities of speech and the causes thereof. This knowledge should be made available to our patients by referring them for further treatment to a qualified individual in that profession. However, it must be said that to be effective such treatment must be done by a person who has a thorough understanding of the problem involved and some knowledge of the appliance with which he is dealing. The breaking of previous habits having to do with shutting off the flow of air through the nasal cavity is an important consideration because of the depth of habit formation. Even though, after the insertion of the appliance, the necessity for such habits is no longer present, the desire to continue the habits is. These habits must be broken. The speech correctionist in his work will do his share to rehabilitate the patient further. Speech correction is a separate specialty. Therefore, I only make mention of it because it is related to the subject which I have been discussing and a vital part in the chain of specialized treatment which must be inaugurated in all cases if the results are to be as gratifying as we would wish.

REFERENCE

Fitz-Gibbon, John J.: Cleft Palate, D. Items Interest **53**:737, 1931.

9400 Euclid Avenue
Cleveland 6, Ohio

THE ROLE OF PERIODONTIA IN PROSTHETIC DENTISTRY

HORTON D. KIMBALL, D.D.S., D.D.Sc.
Detroit, Mich.

THE purpose of this paper is to demonstrate a relationship between periodontia and prosthodontia, and to illustrate the fact that periodontia cannot be successfully divorced from any branch of dentistry.

Perhaps the greatest benefit that one will derive from a knowledge of periodontia in practicing prosthetic dentistry is in his increased ability to diagnose oral conditions correctly. This applies to all phases of prosthetic dentistry, viz., bridge, partial, and full denture construction.

When a patient with periodontal involvement presents himself, the dentist who has had proper periodontal training is able to make his diagnosis, or analysis of the case; his prognosis, or prediction of the results which will be obtained; and his recommendations for procedure with the sincere feeling of certainty that he is doing the best thing possible for that patient. He will be less hasty in advising the removal of involved teeth, and will consequently save more teeth than he had before felt possible. In short, he will be giving his patients better service and better dentistry.

Consider then, the condition of the gingival tissues in cases of periodontal involvement. These gingival tissues are inflamed, and the degree of inflammation may vary clinically from acute to subacute, or to chronic.

It is quite generally accepted that wherever inflammation of soft tissue exists, there is also a degree of inflammation and resultant resorption in the immediately adjacent bony structures. Thus, rheumatic patients exhibit resorption in the bone of the joints which are inflamed. Also, a simple fracture of a long bone will, within a week after the fracture, show radiographic evidence of marked resorption of each end of the fracture.

Leriche and Policard[1] state that rarefaction and resorption of the fragments of a fracture begin immediately after the trauma, and progress to such a degree that after seven or eight days exact anatomic coaptation of the fracture is most difficult.

They further state that such resorption is manifested by enlargement of the Haversian canals and of the connective tissue spaces. The bone disappears by osteoclasis (osteoclastic resorption), much more than by osteolysis (chemical absorption), and as the circulatory conditions return to normal, the rarifaction ceases.

Weinmann and Sicher[2] report that necrosis of bone is always found at the fracture line of simple traumatic fractures.

Received for publication Jan. 9, 1951.

Luck[3] states that since the hyperemia of the fracture area involves the bone as well as soft tissue, there is a progressive osteoporosis of all viable fragments. Calcium salts are released as the bone atrophies, and are retained locally to aid in calcifying the bony callus as it forms.

Thus, it is seen that there is resorption and rarefaction of bone when associated with inflammation. There are, however, differing schools of thought as to the manner in which the rarefaction occurs.

Leriche and Policard[1] feel that it is a vascular absorption brought about by a localized lowering of the pH. This, in turn, they say, tends to cause solution of the calcium salts and results in a widening of the Haversian and Volkman canals of the bone. They refer to this form of bone absorption as "halisteresis," or "osteolysis."

Boyd[4] also feels that in inflammation there is a localized lowering of the pH. He says that the resultant enlargement of the bone canals permits the blood vessels to become dilated, and that well-vascularized bone is absorbed quickly.

Hudak[5] has reported from experiment a shift in the pH after soft tissue injury.

On the other hand, Weinmann and Sicher[2] say that halisteresis of living bone has never been proved, and that it is more probable that the resorption of bone starts with a proteolytic action of the osteoclasts.

Regardless, however, of whether the process is an "absorption" or a "resorption," it seems to be agreed that there is a localized osteoporosis, and an increased vascularity of the bone associated with soft tissue inflammation; and as the inflammation subsides, the bone rebuilds or regenerates along the existing bony or connective tissue matrix.

The process of bone rarefaction also occurs in the mouth in periodontal conditions.

Weinmann[6] says that chronic inflammation of the gingiva progresses following the course of the blood vessels into the bone marrow spaces, and almost invariably on the periosteal side of the alveolar bone. Resorption of the alveolar crest from the gingival side leads to destruction first of the supporting alveolar bone, and then of the lamina dura. The fatty marrow is replaced by fibrous marrow. The effect of gingivitis on the supporting structures is interpreted as osteitis.

Kronfeld[7] speaks of the osteoclastic resorption of the alveolar crests due to the inflammatory process of gingivitis.

Fish[8] has shown how the bacterial infection of a periodontal pocket is confined to the pocket itself, but that the toxic products created pass into the adjacent alveolar structures and create a zone of irritation, wherein there is an osteoclastic resorption. He found that the bacterial organisms are limited to the confines of the pocket by the action of the polymorphonuclear leucocytes. The toxic products of the bacterial infection diffuse into the surrounding tissues, however.

In the area of greatest concentration of toxins the bone cells die, the normal cells of the adjacent soft tissues disappear, and the whole of the soft tissue area involved is converted into a mass of round-cell infiltration.

Beyond the zone of severe contamination, the toxins are more dilute, but are still sufficiently concentrated to constitute a serious irritant. This is indicated by continued round-cell infiltration. It is here that the osteoclasts appear, eating away the bone matrix; while the collagen framework of the adjoining soft connective tissue is being digested by histiocytes.

In turn, beyond the zone of irritation in which the osteoclasts and histiocytes are acting to eliminate contaminated matter, there is a zone of intense cellular activity which is constructive in nature. The toxic products from the lesion are now so dilute that they no longer act as an irritant, but constitute a stimulant to the cells. Fibroblasts lay down a dense mat of collagenous fibers, and osteoblasts build masses of new bone. This new bone is actually a callus formation.

Thus, a sequestrum is formed which may be expelled, or if retained, may enlarge. On the other hand, if proper treatment is instituted, the area can heal.

Although inflammation seems to play the major part in the alveolar resorption of periodontal disease, other factors must also be considered as playing their limited part. As pointed out by Weinmann and Sicher,[2] disuse atrophy may bring about the reduction of supporting bone around a tooth which has lost its antagonist. Likewise, unbalanced and excessive masticatory function on individual teeth may bring about localized bone necrosis due to excessive pressure or tension.

Orban and Weinmann[9] describe a form of diffuse atrophy of the alveolar bone which they classify as "periodontosis," and which is noninflammatory in its initial phase.

They divide the condition into three phases. In the first phase there is degeneration of the principal fibers of the periodontal membrane, and resorption of the alveolar bone. This is due probably to lack of functional stimuli from the teeth, and to increased tissue pressure in the area of degeneration. The increased tissue pressure is caused by the edematous swelling of the fibrous tissues, and by the increased proliferation of the capillaries. There is no inflammatory reaction in this stage. The cause of this primary phase is not certain, but it is thought that intrinsic systemic factors must be considered primarily. Such factors may be found in the dysfunction of different endocrine glands, toxins from different sources, metabolic disturbances, dietary deficiencies, etc.

As the condition progresses into the second phase, the epithelial tissues degenerate, and inflammatory reactions become evident.

With the epithelial degeneration, deep pockets develop and the condition passes into the third phase. In this phase the inflammatory reaction is aggravated, and large portions of the supporting tissues are destroyed. It is this third phase which is clinically most frequently observed.

As they point out, the knowledge of the sequence of events in the development of "periodontosis" is the prerequisite for wise treatment.

Dentists are all familiar with the fact that more hemorrhage is associated with the extraction of periodontally involved teeth than with those which are not so involved. They are also familiar with the eventual high degree of alveolar resorption of these cases as healing occurs and dentures are inserted. They are, in turn, only

too familiar with the number of times that such dentures must be rebased and reconstructed because of continued resorption.

Miller[10] says that bone is a very plastic tissue. It may be considered so in that it responds quickly to forces which tend to destroy or to rebuild it. Just as bone resorption follows destructive influences, so it is possible for bone to regenerate when forces are constructive.

Kronfeld[7] speaks of the fact that radiographic evidence of bone regeneration following treatment of periodontal pockets has frequently been observed.

Dental literature has reported many cases of bone regeneration following periodontal treatment. Box,[11] Miller,[10] Sorrin,[12] Roth,[13] Lusterman,[14] Bjorndahl,[15] and Goldstein[16] are a few of the men who have reported on case histories of such bone regeneration.

It follows then, that under favorable conditions, providing that the health of the patient is not jeopardized, and that his full and complete cooperation is assured, periodontal treatments can promote bone condensation and regeneration. As Miller[10] has pointed out, the dentist armed with the knowledge of how vascular dilatation and stasis of blood flow may bring about an absorption of bone, should do all in his power to prevent inflammatory responses from taking place.

After the dentist has instituted proper periodontal treatment and care in an involved mouth, and the response is favorable, he can then insert correctly designed and constructed prosthetic appliances. Providing the dentist and the patient both do their part to maintain periodontal and oral health, the prognosis that such restorations will give years of satisfactory service is most favorable.

Relative to choice of restorative prosthetic procedures, it is generally accepted that fixed bridgework be done wherever possible. Greater support is thus obtained, and less stress concentrated on any individual tooth or teeth.

Advocates of precision attachment removable bridges may take issue with the above statement. From the practical standpoint, however, relatively few dentists are sufficiently adept to be able to construct precision attachment cases. Furthermore, relatively few patients are financially able to afford such types of restoration. In addition, it is debatable whether a precision attachment bridge will give the supporting and splinting action to the abutment teeth that will be given by a fixed bridge.

Where removable partial dentures are inserted, strong occlusal rests should be used in conjunction with the clasps. Stresses should also be kept as nearly parallel as possible to the long axis of the teeth.

While it may be true that at some future date the teeth might have to be removed, the underlying alveolar process, by virtue of the periodontal treatments, the restorative procedures, and the continued oral care, will have had an opportunity to rebuild. It will have become more healthy and should be better able to receive the stresses of bearing dentures with a minimum degree of resorption.

As Schuyler[17] and Fish[18] have pointed out, the duration of service of any restoration is dependent upon the health of the supporting and related tissues. Mild function or stimulation is conducive to tissue health and development. Excessive function or overstimulation induces inflammation, and resultant bone resorption.

Schuyler[17] has recommended certain procedures to reduce overstimulation during function. These are:

1. The reduction of the application of force to areas of support by:
   a. Reducing the size of cutting surfaces of artificial teeth.
   b. Maintaining or increasing the sharpness of such surfaces.
   c. Reducing the number of artificial teeth used.
   d. Eliminating torque, leverages, and wedging of abutment teeth.
   e. Diminution of horizontal forces by the reduction of lateral tooth inclines.
2. The distribution of the force applied over the greatest possible bearing area by:
   a. Covering the greatest possible tissue bearing area.
   b. Physiological adaptation of saddles to the tissues.
   c. The use of occlusal lugs or rests, dividing occlusal forces between the saddle bearing areas and the remaining natural teeth.
   d. The use of favorable types of clasps in sufficient numbers to distribute lateral stresses between the abutment teeth and the saddle supporting areas.
   e. The maximum distribution of occlusal stress in centric and all eccentric maxillomandibular relations.

To the degree applicable, the foregoing principles of Schuyler's apply equally to fixed and removable bridge construction, partial denture construction, and to full denture construction.

In view of the preceding discussion, it does not necessarily follow that all periodontal involvements should be treated, regardless of severity. It is urged that the greatest care be used in diagnosis and prognosis. In cases where it is felt that constructive forces can be instituted which will be equal to, or greater than the destructive forces already at work, periodontal treatment should be undertaken. As has been previously mentioned, the health of the patient must not be jeopardized, and his complete cooperation must be assured.

Diagnosis must be made most carefully. A hasty diagnosis often precludes rendering service which is advantageous to either the patient or to the dentist. In addition to periodontal involvements, there are many other conditions which are frequently encountered in and about the mouth. These conditions also may bear a direct relationship to physical and to oral health, and to successful full denture prosthesis.

The cracking (cheilosis, or perlèche) occasionally seen in the corners of the mouths of denture patients is usually attributed to a closed vertical dimension and the action of saliva in the angle of the mouth. This is doubtless true in many cases; however, it may also be influenced by a riboflavin (vitamin B_2) deficiency. Frequently, the administration of one 5 mg. tablet of vitamin B_2 three times daily—one after each meal—will give excellent results in aiding to clear up the condition.

Glossitis (burning tongue) and stomatitis (burning under dentures) can be brought about by a niacin deficiency. In these cases, one 100 mg. tablet of niacin three times daily—one after each meal—will often give relief.

Burning tongue is also one of the diagnostic symptoms of pernicious anemia.

Patients whose gall bladders have been removed usually avoid fats, and an oral pellagra may result. This also is a niacin deficiency.

Another cause of burning in oral tissues is the organic change brought about during menopause. In these cases, the physician can often help by the administration of estrogenic hormone.

Some have recommended the use of vitamin D in conjunction with a high calcium diet as a means of preserving the ridges under prosthetic appliances. Three glasses of milk daily with 400 to 500 units of vitamin D is the recommended amount. Care must be taken however, not to overdose with vitamin D. Hypervitaminosis D may bring about a hypercalcemia with resultant excess excretion of calcium in the urine. This in turn depletes the calcium store in the bones. It is highly advisable to have the necessary blood tests run before entering into this type of therapy, and then to work in conjunction with a physician. There is, furthermore, considerable question as to whether this form of therapy has any practical value in this type of work.

A vitamin C deficiency may bring about a form of oral scurvy. In the edentulous mouth it may be manifest by extreme hyperemia. This may be particularly noticed beneath the dentures, and may be associated with considerable tenderness when wearing the dentures. Such patients usually also exhibit a marked tendency to bruise easily. One 100 mg. tablet of ascorbic acid given three times daily after meals often proves helpful.

Leucoplakia treatments may be supplemented with the use of high vitamin therapy. Certain "therapeutic" commercial vitamin capsules contain high dosages, such as: 25,000 units "A," 1,000 units "D," 10 mg. "B_1," 5 mg. "B_2," 150 mg. niacin, and 150 mg. "C." Three such capsules may be taken daily, along with three capsules of dessicated liver, also taken three times daily. In addition, there is to be no smoking, no alcohol, and no oral irritants.

It is well known that dilantin sodium used in treating epilepsy will, in some individuals. produce gingival hypertrophy. It has not been established that this will occur in an edentulous mouth, although the author had a case recently where this medication was strongly suspected to be the factor in the production of a soft hypertrophied type of ridge. In such edentulous instances where hypertrophy exists, and the use of dilantin is a possible contributing factor, the superfluous soft tissue should be removed before constructing dentures. In the construction of the dentures, extreme care should be taken to follow the principles laid down by Schuyler[17] to reduce overstimulation during function. By so doing, the possibility of the patient developing more hypertrophied tissue will be reduced.

Dr. Percy Lowery was one of the pioneers in recognizing the fact that diabetic patients are apt to be subject to greater than average tissue changes when wearing dentures. Such patients are, because of the nature of their condition, often

quite intractable and difficult to handle. It is highly advisable in these cases to check with their physician on their blood sugar level. It should be emphasized to the patient that it is of vital importance for the blood sugar level to be correctly maintained in order better to assure continued success and satisfaction with the dentures.

Secondary anemia will frequently cause the mouth to become more sensitive than normal when wearing dentures. There may not be any perceptible lesions whatsoever. If there is any question of this in the dentist's mind, it is a simple matter to refer the patient to a clinical laboratory for a complete blood count. Then, if necessary, the patient can be referred to a physician for treatment.

Individuals who wear full dentures are frequently apt to have an inadequate diet, due to their difficulty in masticating certain foods. These patients, particularly the older people, often avoid meats and fall into the so-called "tea and toast" eating habits. Consequent undernourishment and protein deficiency can result. This may be manifested clinically by loss of weight and energy on the part of the patient. There may also be present a secondary anemia, a decreased resistance to infection, and a nutritional edema.

In these nutritional disorder cases, it is virtually impossible for the patient to experience satisfaction with the dentures. Actually, it is a vicious cycle, i.e., the dentures make the mouth sore, so the patient eats soft foods and develops varying degrees of malnutrition condition present, the mouth becomes more sensitive than ever and less able to receive the stresses of mastication, and so on. In such cases of malnutrition due to inability to masticate properly, the aid of a physician should be enlisted to restore the patient's physical condition. It is obvious that the utmost care must be employed in denture construction to reduce the possibility of tissue soreness, and to increase masticating efficiency.

In connection with nutritional disorders is the Plummer-Vinson's syndrome. Clinical Nutrition[10] describes it as a functional disorder of swallowing, with anemia, and enlargement of the spleen. Associated with this are glossitis, cracking of the skin at the corners of the mouth, and other nutritional disorders. This condition is thought to predispose to carcinoma of the esophagus, and the nutritional disorder may be a primary factor in its development.

There are numerous other conditions such as blood dyscrasias, glandular dysfunctions, and systemic diseases which unquestionably play a part in the successful and satisfactory wearing of dentures. It is not possible in the scope of this paper to enter into all of them, and neither is there sufficient knowledge available at the present time to establish their definite relationship. Much work still remains to be done along these lines.

Relative to the patients leaving their dentures in when they retire at night: some dentists advise their patients to remove them; while others tell their patients to leave them in; and the patient usually does as he pleases anyhow. There is considerable merit in the argument that by removing the dentures, the tissues are given an opportunity to regain their normal tone. Another factor must be considered also, however: many people grind their teeth in their sleep. This

condition (bruxism) is most difficult to control when one has his own natural dentition. It is, along with the habit of clenching the teeth when awake (bruxomania) a great factor in the production of periodontal disturbances. If the denture patient grinds his teeth in his sleep, he is not only very likely to mechanically damage his dentures, but he is also quite certain to create sore areas in the mouth, and to stimulate more alveolar resorption. These patients should, by all means, be instructed to leave their dentures out when retiring.

In regard to temporomandibular disturbances, some suggestions may help to supplement the therapy already decided upon. When pain exists, Miller[10] has suggested the possibility of a vitamin deficiency to be considered among other things. He suggests the use of one 10 mg. tablet B_1, one brewer's yeast tablet, and one 100 mg. tablet of ascorbic acid three times daily—after each meal. Vitamins, being a supplemental food, absorb better with food in the stomach.

Miller[10] has also pointed out that the time of the discomfort may be an aid in diagnosis. If joint pain occurs before eating, and function improves it, the condition is likely to be systemic. If, however, the pain becomes more severe with function, it is suggested that in addition to the factors usually considered, one also check the occlusion. This is done to make certain that no occlusal force exists which may tend to force the head of the condyle distally. This may be caused by lower second or third molars which are tipped mesially that strike the distal inclines of the upper molars. The author has found that in some cases of closed vertical dimension, the lower incisors may strike the inclined lingual surfaces of the upper incisors. Instead of producing a periodontal disturbance, the mandible may be forced backward (distally) to produce condylar discomfort. Occlusal adjustment, of course, helps these cases greatly.

It is hoped that this paper will help dentists to remember that not all persistent denture discomforts are due to purely mechanical local causes; but that systemic conditions can, and do, exert their influences, although such influences may not always be apparent.

REFERENCES

1. Leriche, R., and Policard, A: Normal and Pathological Physiology of Bone, St. Louis, 1928, The C. V. Mosby Co.
2. Weinmann, J., and Sicher, H.: Bone and Bones, St. Louis, 1947, The C. V. Mosby Co.
3. Luck, J. V.: Bone and Joint Diseases, Springfield, 1950, Charles C Thomas.
4. Boyd, Wm.: Textbook of Pathology, ed. 5, Philadelphia, 1947, Lea and Febiger.
5. Hudak, C. S.: Clinical Basis for Bone Healing, J. Periodont. **19:** 7-10, 1948.
6. Weinmann, J.: Progress of Gingival Inflammation Into the Supporting Structures of the Teeth, J. Periodont. **12:** 71-82, 1941.
7. Kronfeld, R.: Histopathology of the Teeth and Their Surrounding Structures, ed. 3, Edited by Paul E. Boyle, Philadelphia, 1949, Lea and Febiger.
8. Fish, E. W.: Bone Infection, J.A.D.A., **26:** 691-712, 1939.
9. Orban, B., and Weinmann, J.: Diffuse Atrophy of the Alveolar Bone (Periodontosis), J. Periodont. **13:** 31-45, 1942.
10. Miller, S. C.: Textbook of Periodontia, ed. 3, Philadelphia, 1950, Blakiston Co.

11. Box, H. K.: Bone Regeneration After Periodontal Treatment, D. Survey **15:** 778-779, 1939.
12. Sorrin, S.: Ten Year Study of Osteofibrosis, Am. J. Orthodont. & Oral Surg. **30:** Sec. Oral Surg., p. 329, 1944.
13. Roth, H.: Alveolar Bone Regeneration, New York J. Dent. **13:**26-27, 1943.
14. Lusterman, E. A.: Bone Regeneration Following Periodontic Treatment, J. 2nd. Dist. Dent. Society, New York, **29:**236-237, 1943.
15. Bjorndahl, O.: Reattachment and Bone Regeneration, Report of a Case, J.A.D.A. **36:** 356-358, 1948.
16. Goldstein, A.: Bone Regeneration With a Periodontal Splint, J. Dent. Med. **4:** 67-68, 1949.
17. Schuyler, C. H.: Oral Diagnosis And Treatment, S. C. Miller, ed 2, Philadelphia, 1946, Blakiston Co., Chap. 17.
18. Fish, E. W.: Paradontal Disease, London, Eyre and Spottiswoode, 1944.
19. Clinical Nutrition: Edited by N. Jolliffe, F. F. Tisdall, and P. R. Cannon, New York, Paul B. Hoeber, Inc., Medical Book Dept., Harper & Bros., 1950.

873 Lakewood Blvd.
Detroit 15, Mich.

GERIATRICS AND DENTAL SERVICE

I. M. HUGEL, D.D.S.

New York, N. Y.

THE present increase in life expectancy among the now middle-aged population is placing greater emphasis upon the restorative phases of dental service. The current trend of patient education, resulting in a better informed public, is producing an appreciable broadening of the scope of preventive dentistry. But the benefits of research in the causes and prevention of tooth decay and periodontoclasia will be largely realized only by later generations. Regardless of the advances now being made we are still confronted, and will continue to be confronted for quite a few years, by an overwhelming number of patients in need of adequate restorative dentistry.

Many of these patients have but few remaining teeth, and ordinarily would be considered pre-edentulous. However, in view of this longer life expectancy, it is decidedly advisable to attempt to retain and utilize what remains of the natural dentition. The reluctance of the middle-aged patient to submit to complete extractions and full dentures is recognized as an emotional problem. Of course, these cases often pose a functional problem as well. Usually these patients are discouraged because they have been told that a partial denture would not be comfortable and would cause accelerated alveolar resorption. They have been advised that they lack sufficient bone and tooth support for a restoration that will function satisfactorily, and that if construction of a partial appliance were undertaken, full dentures would be inevitable within a short time.

It is a fact which many dentists will attempt to deny but whose truth is borne out in the light of experience, that partial dentures in a majority of instances do cause periodontal damage to clasped and even to other remaining teeth. They do this because of the stresses imposed by clasp arms and the lack of stability under function which is characteristic of such restorations. Clasps also cause decalcification, sensitiveness, and, in a large number of cases, actual caries in clasped teeth. Discomfort, often to the extent of inhibiting the use of the appliance, is a common complaint of patients wearing typical partial dentures retained by clasps.

These objectionable features of the clasp denture are eliminated in the properly planned movable-removable bridge, and the successful results obtained with this restoration indicate that the dire predictions and foreboding diagnoses made regarding the usual partial denture are without foundation, with the internal attachment case. The possibilities presented by this type of restoration should be given careful consideration in many so-called borderline cases.

Received for publication Jan. 16, 1951.

There are important reasons why the movable-removable bridge has been so successful. In the first place, internal attachments properly paralleled cause no torsional or lateral strains on the abutment teeth either on insertion or withdrawal. Then, during functional use, these attachments provide for a very slight vertical

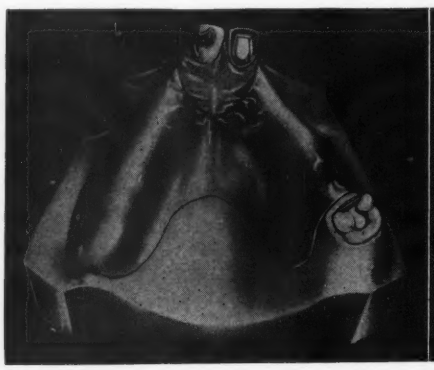


Fig. 1.

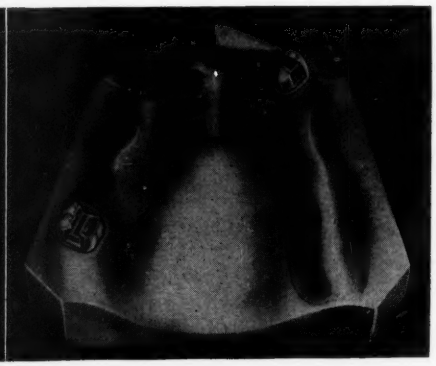


Fig. 2.

Fig. 1—Cast showing remaining natural teeth with preparations and saddle design. The right central had been devitalized, and an inlay anchored by a post was used. Attachments were placed on the distal of each upper central and on the mesial of the upper left second molar. (Photographs reproduced from McCall and Hugel: Movable-Removable Bridgework, 1950, by permission of Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

Fig. 2.—Cast showing remaining natural teeth with preparations and saddle design. Attachments were placed on the mesial of the upper right second molar and mesial and distal of the upper left cuspid. (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

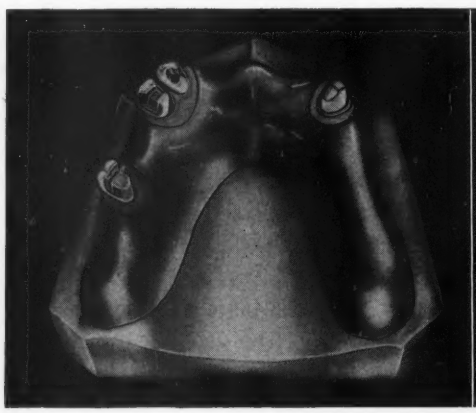


Fig. 3.

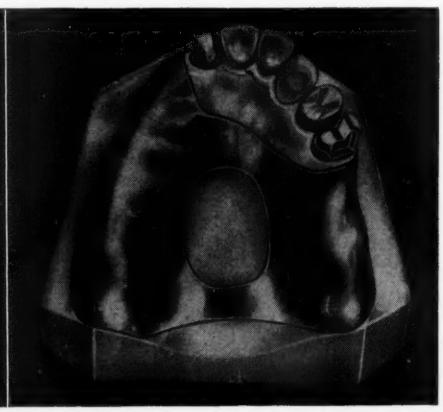


Fig. 4.

Fig. 3.—Cast showing remaining natural teeth with preparations and saddle design. Attachments were placed on the distal of the upper right first bicuspid and upper right second molar; mesial and distal on upper left cuspid. Interlocking lugs were placed on the mesial of the upper right second molar and upper right cuspid. (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

Fig. 4.—Cast showing remaining natural teeth with preparations and saddle design. A veneer crown was placed on the upper right central. Attachments were placed on the distal of the upper right central and upper left second bicuspid. (Well-formed tuberosities aided in retention.) (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

movement whereby the major stress of the bridge is borne by the ridge tissue under the saddle. The only contact of the removable male attachment and the teeth used as the abutments is on the female part of the attachment. There is no contact with enamel, hence there is no tendency to sensitiveness and caries.

Figs. 1 through 12, showing the number and position of teeth remaining in each instance, demonstrate cases for which precision internal attachment bridgework has been constructed with most favorable results. Some have been worn for more than fifteen years, and are still giving satisfactory service.

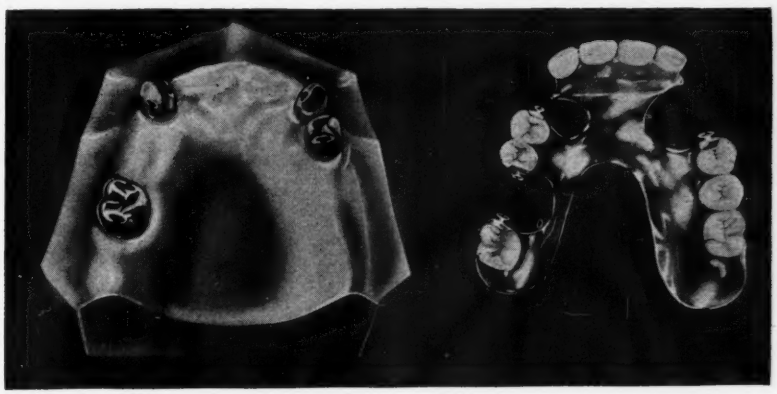


Fig. 5. Fig. 6.

Figs. 5 and 6.—Occlusal view of cast and bridge. The anterior section of the bridge was made with porcelain teeth set in an acrylic base to build this part out for restoration of lost bone structure. (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

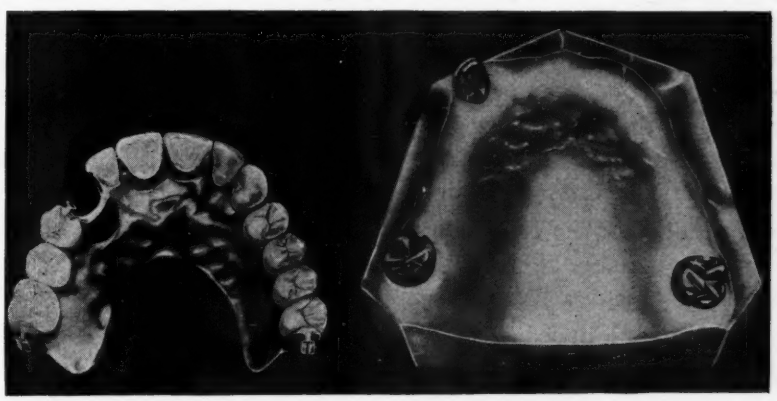


Fig. 7. Fig. 8.

Figs. 7 and 8.—Occlusal view of bridge and cast, the patient having only three remaining teeth. Note that full palatal coverage is not indicated. (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N.Y.)

In planning a movable-removable bridge, it is necessary to evaluate the condition and position of remaining teeth and the surrounding alveoli, edentulous ridge tissue and underlying bone, and the condition and position of the teeth in the opposing jaw.

The basic requirement governing the position of remaining teeth for use as abutments is that there shall be teeth on each side of the center line and, in the absence of posterior teeth, at least both cuspids shall be usable. However, in lieu of a cuspid, a long sound central incisor will suffice.

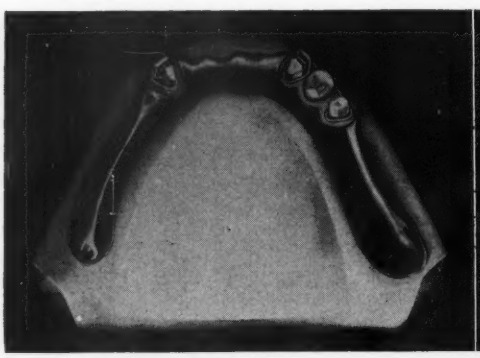


Fig. 9.

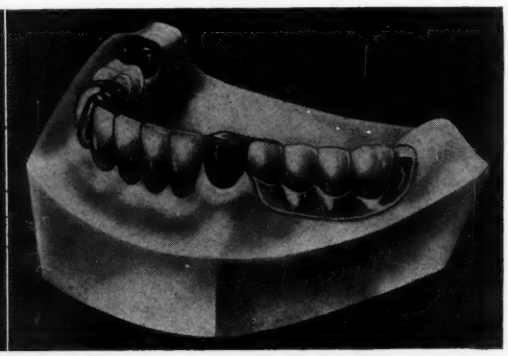


Fig. 10.

Fig. 9.—Cast showing remaining natural teeth with preparations and saddle design. A veneer crown was placed on the lower right second bicuspid. Attachments were placed on the distal of the right second bicuspid and left cuspid and on the mesial of the right cuspid. An interlocking lug was placed on the mesial of the left cuspid. (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

Fig. 10.—Labial view of a distal extension movable-removable bridge employing a stress breaker. (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

Caries or fillings which approach the pulp of the proposed abutment tooth should be carefully evaluated as to the effect they may have had on pulp health. Degenerated pulps beneath deep fillings may remain quiescent until a new filling or inlay is inserted and may then flare up with an acute pulpitis. However, with the older patient, the pulp chamber has usually receded somewhat, and the defensive reaction to caries and fillings has produced secondary dentin formation, all of which results, in most cases, in minimal risk to the pulp when preparing the tooth.

Teeth with malformed crowns or anomalies of anatomy may be used as abutments providing they can be prepared to house female attachments of suitable size within the circumference of the crown.

Malposition as to tipped or rotated teeth is not a contraindication for use as an abutment if the tooth can be prepared with an exaggerated slice and the occlusal level can be properly established so that it can be brought within the lines of occlusion and position it is desired to establish.

Teeth that have elongated due to loss of antagonists may be utilized if there has not been extreme resorption of alveolar support and gingival tissue, and if it is

possible to shorten and reshape without weakening the remainder of the structure. Where the only tooth which can be used as an abutment has elongated to the extent that shortening will cause pulp damage, root canal therapy would be advisable if the roentgenogram indicates a favorable prognosis for such treatment.

Variations in regard to the extent of permissible alveolar resorption depend not only on root length in relation to length and size of crown, but on whether the tooth is single or multirooted. The tooth with an abnormally short root in relation to its crown will require more alveolar support than will the tooth with a long root. Multirooted teeth such as upper first bicuspids, and upper and lower first molars, need relatively less remaining alveolar bone than single rooted teeth.

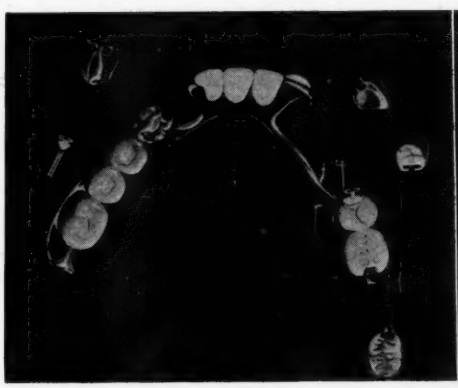


Fig. 11.

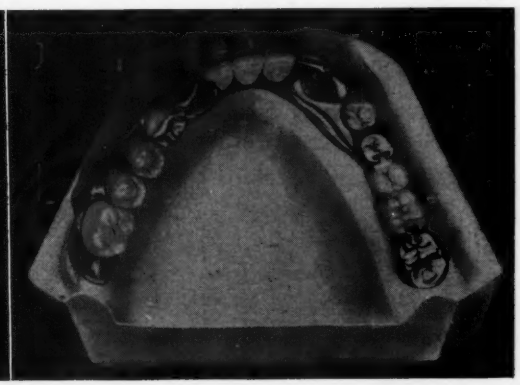


Fig. 12.

Fig. 11.—The bridge shown in Fig. 10. The finished bridge, abutments, and distal extension components are illustrated. (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

Fig. 12.—Occlusal view of the bridge shown in Figs. 10 and 11. (Courtesy Dental Items of Interest Publishing Co., Brooklyn, N. Y.)

An important consideration in arriving at a diagnosis where alveolar resorption has taken place is the length of the intra-alveolar lever relative to that of the extra-alveolar lever, the latter being that part of the tooth which extends beyond its alveolar support. If there has been much loss of bone and the crown of the tooth is quite long, the leverage on the tooth may be unfavorable for its stability even though the anatomic root length may be normal. On the other hand, a tooth with a somewhat shorter root but with bone support extending well into the coronal third of the root may be used as an abutment because the ratio of the extra- to intra-alveolar lever is favorable.

Gingivitis, if not complicated by systemic conditions such as uncontrolled diabetes, presents no contraindication to the placing of a bridge. It is essential, however, that the gingival disease be brought under control and proper gingival contour be established by periodontal treatment before construction of the bridge is undertaken.

The bone of the edentulous areas should be studied roentgenographically to determine the presence of root tips, areas of residual infection, impacted and supernumerary teeth, cysts, and tumors. Any of these that are found should be removed. There also may be spiny or other osseous protuberances which remain because of incomplete resorption of alveolar septa after tooth extraction or from alveolar resorption due to varied causes. Smoothing of the osseous surfaces before proceeding with bridge construction is essential for later comfort.

Unduly soft or flabby edentulous tissue upon normal structure should be surgically removed so that a firm support for the bridge saddle will be provided. If, on the other hand, the underlying bone is infected or presents undue rarefaction roentgenographically, a flap of gum tissue should be laid back and the necessary curettage performed. Here also, some trimming of soft tissue should be done to eliminate a resulting flabby condition. Pronounced undercuts in the alveolar ridges which will interfere with the insertion and removal of the bridge should be eliminated by an alveolectomy. However, it should be borne in mind that well-formed tuberosities aid in retention of the bridge, particularly in the absence of posterior abutment teeth.

The teeth of the opposing jaw should have normal occlusal anatomy, and all pressures which might result in traumatic occlusion should be relieved.

The arches should be in such relationship that a satisfactory occlusion for the bridge can be established.

The health of the patient must be judged from the standpoint of his ability to undergo the series of appointments and the operative procedures required in the construction of a precision attachment bridge. Advanced age in itself, however, is no deterrent to the construction of a bridge providing the patient is in reasonably good health and not actually feeble. In fact, the desire of elderly patients to retain their own teeth very often will make them exemplary dental patients.

In view of the successful mouth reconstruction which can be accomplished with movable-removable bridgework, hasty condemnation of remaining teeth, even if few in number, is not in the patient's best interests. The feasibility of constructing a restoration of this type should be given thoughtful consideration, for the effect of the prospect of full dentures upon aging patients, particularly from the psychological aspect, is not to be underestimated. The desire of patients to retain and prolong the use of their own teeth is natural and understandable, and in many cases need not be discouraged.

745 Fifth Avenue
New York 22, N. Y.

OCCLUSION

ELAM HARRIS, D.D.S.

Louisville, Ky.

"OCCLUSION is the most important subject in all departments of dentistry, with the possible exception of surgery."[1]

Centric occlusion of the teeth may or may not coincide with centric relation of the mandible to the maxilla. When such harmony does exist it is a fortunate and beautiful thing. It is correct mandibular posture. It is then that disturbances of dental origin are reduced to the minimum; dental care and corrections to their simplest forms and dental health and function are most easily maintained. When harmony between centric occlusion of the teeth and centric relation of the mandible does not exist, malocclusion does exist. Our first duty is to detect such disharmony and correct it. When this is done, condyles will function on their hinge axes, and the muscles and ligaments that move, control, and stabilize the mandible will function normally unless disturbed by other causes. Dentures will give less trouble, periodontal diseases will respond to treatment more readily and more satisfactorily, retaining appliances will be required for a much shorter period, and there will be fewer cases of teeth drifting back into an unsightly alignment following orthodontic treatment. Restorations will function better and last longer. Dentists will cease to be on the defensive before the public, and the medical profession and our morale will be better.

Establishing centric occlusion of the teeth to coincide with centric mandibular relationship is by far the most important step in establishing correct occlusion. In the study of occlusion, one marvels at the knowledge, the ingenuity, and the skill that many of our profession have displayed in the production of devices for copying and recording the various subtle and delicate movements of the mandible. We are grateful for and completely fascinated by the contributions of these resourceful men. In fact, we have at times become so fascinated by the possibilities which the study of occlusion offers that we have lost sight of, forgotten, or neglected the great and first fundamental underlying any study of occlusion, whether it be of natural or artificial teeth, namely, "centric mandibular relation." No position which the mandible may assume is unimportant. It must not be said that the importance of eccentric mandibular positions and movements have been exaggerated. It is better to say that in the study of these very fascinating positions and movements we have neglected mandibular centric. We have, after a fashion, taken it for granted.

Reprinted from the Kentucky State Dental Association Quarterly Journal, January, 2: 38, 1950.

Received for publication, Jan. 10, 1951.

Considerable study and research have centered on periodontal disease and orthodontic treatment. They have been approached from many angles. Many theories, treatments, and techniques have been advanced, sometimes with little or no consideration for the great fundamental, "centric mandibular relation." Considerable study and research have centered on disturbances having their origin in the temporomandibular joints. For a time an "air of mystery" surrounded the study and treatment of these disturbances. This subject, so far as dentistry is concerned, is now placed where it belongs. It is, in reality, a problem of occlusion of the teeth. Establish proper occlusion and all has been accomplished in such cases that dentistry can do.

In all our various dental operations we may choose from many techniques, instruments, and materials. This is especially true in impression techniques for denture construction. Successful dentures can be made by using any of the good, recognized techniques and materials if the dentures are built to centric. There is only one centric. None are wholly successful if we miss centric. The same is true of the many techniques and materials used in restorative dentistry. Innumerable good techniques and materials are available for such work, and good results may be obtained by the use of any or all of them, provided the restorations are made to the correct bite or centric. Beautiful and perfectly constructed inlays, crowns, bridges, or partials are to be admired only for the skill employed and pitied if constructed to an eccentric relation. No restorations involving the occlusion should be made in a mouth containing any natural teeth until these natural teeth have been made to occlude in centric in the best possible manner so that the patient can maintain that position without sliding into an eccentric position. This can usually be accomplished by grinding. The occlusion thus established between the remaining natural teeth may not be all that is desired but the restorations to follow can take care of that. It is astonishing that so little attention has been given to balancing the natural dentition in centric relation when so much has been said and done about balancing artificial dentures. If artificial dentures, unbalanced and out of centric, will destroy the bony foundation and cause discomfort, what may we expect the unbalanced and eccentric natural dentition to do to the bony structures? Therein lies the answer to much of our periodontal disease.

We should not blindly accept as correct the occlusion of the remaining natural teeth in patients presenting for restorative dentistry. In fact, it is my observation that when a patient needs restorations, particularly if they are at all extensive, the occlusion the patient has is wrong in 95 per cent of the cases. The temporomandibular joints are subject to the same diseases as other movable joints. When trouble in these joints is of dental origin it is due to malocclusion. Whether the patient has natural teeth or dentures it is still malocclusion. Natural dentures can "miss the bite" the same as artificial dentures.

In view of all this, it is proper to ask, "What is this thing called centric mandibular relationship?" It is the position in which the muscles, in normal

relaxation, with no interference, will place the mandible when at rest. This is referred to as the "rest position." True centric occlusion is where the muscles, when not interfered with, will place the mandible when bringing the teeth into occlusion. Many patients are uncomfortable and do not know it, because they have never had balanced occlusion, and dental comfort and efficiency with which to compare their experiences. Many people have symptoms which we now recognize as originating in the temporomandibular joint, caused by malocclusion. Many of these symptoms are referred and are, therefore, misleading. Unless the dentist and the physician are familiar with these symptoms and know that as a result of malocclusion of the teeth the temporomandibular joints may be insulted and injured and cause referred symptoms, the patient may never get relief because it is a dental problem, unrecognized as such.[2]

Beginning now, instead of using the terms "centric relation of the mandible to the maxilla" or "centric mandibular relationship," I shall use the old familiar term "taking the bite." The expression "taking the bite" will not include lateral or protrusive positions or movements. It will include centric position only. Once centric is obtained, a favorite technique may be followed using instruments of choice to record other positions and movements.

In taking the bite two major difficulties confront us. These in the order of their importance are: first, "trismus or abnormal muscular tension"[3]; and second, remaining natural teeth which when brought into their acquired or functional occlusion guide or even force the mandibule out of centric. Muscles and muscular spasm or trismus at once become a very important consideration. Trismus, as it affects the work of the dentist, is a subject that is being studied seriously by some members of our profession. Space will not permit a discussion of trismus now but a serious consideration and study of the subject is recommended to our profession. I can only say here that the causes of trismus or abnormal muscular tensions are many. Pain, discomfort, habit, emotional upset, and condition of health all may be causes. Business reverses or anxiety over business conditions or family adjustment problems frequently cause or contribute to abnormal muscular tensions or trismus. Patients with such problems constitute typical cases frequently encountered by the dentist. Malocclusion of the teeth is one of the frequent causes of trismus of the muscles attached directly or indirectly to the mandible.

The first requirement in taking the bite is relaxation of the patient. When this is accomplished, the muscles will take the mandible to centric unless interfered with by bite rims or other apparatus. Thirty-eight years ago, when I began practice in the hills of my native Kentucky, there was a very strict rule, almost an unwritten law, that no dentures were made in less than six months (frequently longer) from the time the last teeth were removed. It was found that better results were obtained in this way and the reason given was that the gums had time to heal and "shrink." It is my opinion the good results were not so much due to the healing and shrinking of the gums, over a period of six months or more, as to the mandible being freed from the interference of teeth which compelled the muscles to function in a strained

and unnatural position while chewing. Being free from this strain and unnatural tension after the teeth were extracted, the muscles recovered and returned to normal, the mandible was suspended and controlled by unstrained muscles and when the itinerant dentist placed a quantity of beeswax in the patient's mouth and said "close" he got centric. In the edentulous child we have centric. It is only when teeth erupt that a possibly disturbing element enters upon the scene. The patient without teeth for six months returned to his second edentulous childhood and to centric.

So, relaxation of the patient is placed at the top of the list of requirements for taking the bite.

Occlusion being the most important subject in all departments of dentistry, and a correct bite being absolutely necessary to the establishment of proper occlusion, then it logically follows that taking the bite is the most important operation the dentist is called upon to perform. If a surgeon is to perform his most important operation he sees to it that the patient is carefully prepared for it. The patient is hospitalized and medicated. Various tests and examinations are made to determine whether or not the patient is in condition for the operation. All these things are done at the patient's expense, mind you. Contrast this with the dentist's preparation of the patient for his most important operation. Rarely is any special preparation made for taking the bite. The patient may present in a highly nervous and tense state. If the usual methods, with which we are all familiar, do not produce relaxation of the patient, medication is advised. An appointment for taking the bite is made some three days in advance. During these three days the patient should take 0.5 grain phenobarbital three times a day. Hot, wet packs should be applied to the face and the temporomandibular joints for fifteen minutes out of every two hours during the day. The patient should be limited to soft foods and have plenty of sleep. If the patient cannot be trusted to faithfully follow these instructions at home, then it is not only our privilege but it is our duty to hospitalize the patient to assure the best results. On the day the bite is to be taken the patient should arrive at the office thirty to forty-five minutes before the hour set for the operation. Immediately upon arrival 0.75 to 1.5 grains Nembutal should be given. Following this preparation the patient will be able to relax and close. The mandible will drop back with a sort of "thud" as the condyles assume their position in the fossae. We have successfully performed our most important dental operation. We have "taken the bite."

In overcoming the second difficulty, namely, "teeth that guide or force the mandible into an eccentric position," relaxation is again first in importance, and the same methods may be used to secure relaxation. Always keep in mind the great fundamental that muscles in their normal state will take the mandible to centric if all interference is removed. What are the interferences?

1. *Muscular spasm, trismus or abnormal tensions.* We have just outlined a procedure for overcoming this.

2. *Teeth that contact prematurely on some point, cusp, bridge, crown, inlay, or filling that guide the jaw away from centric.* Even a sensitive tooth may be the cause of unnatural chewing until the teeth establish an occlusion out of centric.

Premature contacts on points, cusps, bridges, etc., may be removed by grinding, extraction, removal of the crown, bridge, inlay, or other restoration that is interfering. How to make an analysis and determine what the interference is and what to to about it requires a technique that is long, tedious, and difficult to describe but not difficult to execute.

To those who have never made a comparison of a patient's centric and acquired or false occlusion, I assure you a surprise is in store for you. Yes, a great thrill awaits you. Many are the cases where we felt compelled to do a so-called "bite-opening" in order to remove interference and secure adequate space for a jacket or other restoration, particularly of the anterior teeth. All of us are familiar with the closed bites, the erosion on the lingual of the upper anterior teeth to such an extent that restorations cannot be kept in the teeth. Before "opening the bite" to provide room for restorations, try finding the patient's centric and in most cases you will have all the space needed to make the desired restorations without opening the bite. In fact, few bites ever need to be opened. Occlusal reconstruction does not necessarily mean opening bites. It means providing good occlusion in centric so the patient will not be forced into an eccentric position in chewing. Bite-opening may permit the muscles to take the mandible to centric. If this occurs it is not because of the "opening." It is because whatever was done happened to remove the interference that prevented the muscles from taking the mandible into centric. The muscles are just waiting for the opportunity to move the mandible to centric. When the mandible has moved into centric the condyles will then function on their hinge axes and usually quite a wide opening of the jaw is necessary before the condyles move forward again.

May I repeat, when interference is removed the mandible does not have to be forced or guided into centric or normal position. The muscles will gladly take it there, but remember trismus or muscular spasm is one of the interferences to be removed or overcome and it may require time, after the occlusal interferences are removed, for the muscles to return to their normal state and return the mandible to centric. Another important fundamental to remember is that the muscles are constant, that is, they cannot be stretched or overextended and kept that way without great injury to other tissues. Thompson proved quite conclusively that the rest position is constant throughout life.[4] If this is true, then it must follow that the muscles are also constant because they control the rest position. The muscles being constant, centric relation of the mandible is constant; therefore we cannot force or compel the mandible to conform to dental restorations built to an eccentric position or to an eccentric occlusion established by the orthodontist. The muscles will not permit it.

Because time is usually (but not always) required for the muscles to recover from trismus, after occlusal interferences are removed, any change in the bite should first be accomplished, whenever possible, by temporary appliances. This will prevent much grief.

In all our work if we will remember to provide mandibular freedom so the muscles, which are constant, may take the mandible where *they* want it to go, and

then build occlusion to that position we will have the assurance that our efforts have been in harmony with the great underlying fundamentals of good dentistry. This is a very comforting thought.

SUMMARY

1. Occlusion is the most important subject in all departments of dentistry, with the possible exception of surgery.

2. Finding and establishing centric relation of the mandible to the maxilla is the most important step in establishing correct occlusion (correct bite).

3. There is only one centric and it is constant.

4. The mandible does not have to be forced or guided into centric position. Remove all interference and the muscles will gladly take the mandible into centric.

5. When the mandible is in centric, the condyles will be in their normal position in the fossae and will function on their hinge axes.

6. To secure centric, relaxation of the patient is essential and a serious study of trismus or muscular tension is advised.

7. "Taking the bite" is the most important dental operation. Let us properly prepare our patient for it.

8. Centric relation of the mandible to the maxilla is where the muscles, when normal, and at rest, want it to be.

REFERENCES

1. Swenson, M. G.: Complete Dentures, ed. 2, St. Louis, 1947, The C. V. Mosby Company, p. 213.
2. Costen, J. B.: Ann. Otol Rhin. & Laryng., **43**:1, 1934.
3. Block, Louis: Muscular Tensions in Denture Construction, read before Full Denture Section, A.D.A., Chicago, September, 1948; The Academy of Denture Prosthetics, Indianapolis, June, 1949; Full Denture Section, A.D.A., San Francisco, October, 1949.
4. Thompson, J. R.: The Rest Position of the Mandible and Its Significance to Dental Science, J.A.D.A., **33**:151, 1946.

FINCASTLE BLDG.,
LOUISVILLE, KY.

PRACTICAL OCCLUSION IN RELATION TO COMPLETE DENTURES

JESSE V. BOSWELL, D.D.S.

Springfield, Mo.

IN ANY dissertation upon the subject of practical occlusion, it would seem necessary for us to discuss some factors which are creative of our opinions as to why some of the problems of denture prosthesis, including that of occlusion, have not been satisfactorily answered and solved.

There are a number of prominent factors in the making of dentures. Often one or another of them may be exalted and overemphasized as being the most important.

Since failure may result from the incomplete or improper use of any one factor, it is wise to regard each as especially valuable in its place, and the whole perfected. In none of them should it be necessary to have to resort to complicated measures, for the object may be obtainable through simpler means. Some of the most useful dentures this dentist and others he has known ever produced were among those made half a century ago, when we knew only plaster complete and plaster wash impressions, plaster casts, stock metal trays, plain line articulators, gum-section teeth, and vulcanite bases. Esthetic values may have been low, it is true, but physiologic service was generally high.

It seems that the problems in this field have arisen, not on account of lack of learning, but on account of much projection of certain erroneous concepts concerning physiologic mandibular movements and other influencing factors.

CONFUSIONS

Recently a British dentist, Horace A. Boyle,[1] spoke of the situation thus: "There is much confusion in theory and practice in relation to complete dentures."— "It is probable that many teachers are not satisfied with the prosthetic systems which they teach to their undergraduate students. Further, it is readily conceivable that such preceptors would welcome as timely the pronouncements of a committee of referees after it had examined the several divergent theories and technical methods."

An article by Young[2] contained this: "A recent survey indicates that less than 25 per cent of the dentures in use have been successful from the day of insertion. It also indicates that through continuous wearing about 25 per cent of the dentures

Presented at the Midwinter Meeting of the Chicago Dental Society, February, 1950.
Received for publication Feb. 21, 1951.

achieved this success by tissue and functional adjustments, and that about 10 per cent were total failures, with the remaining dentures in the indeterminate stage. Such reports accurately evaluate the effectiveness of our denture service, and it must be concluded that prosthodontists do have problems that need solving. It is apparent to any dentist who gives a little thought to the profession's denture service that the correctness of present-day theories and techniques taught in colleges and in general use by the profession are and should be questioned." "——It would seem, therefore, that much of the trouble encountered has been caused by the attempt to incorporate the present concepts of balance rather than by failure to attain it."

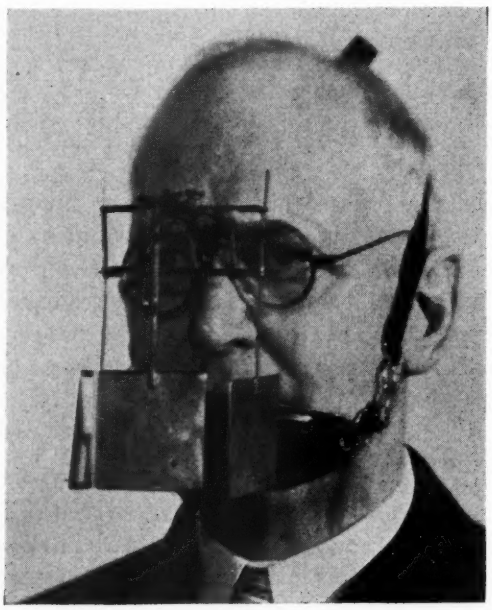


Fig. 1.—Mandibulograph. An instrument for recording the actual masticatory mandibular movements, which are proved to be cyclic in character.

WRONG TEACHING

As a profession we should awaken to the fact that something is wrong with our teaching and practice. When our young graduates enter the practice of what has been taught them, they have great difficulty meeting the conditions attendant upon complete denture prosthesis. Many older men, too, notwithstanding their faithful attendance upon society meetings and refresher courses, are in similar experiences of disappointment and despair.

The wrongness must be something other than sheer inability to master this or that technique or teaching presented. Possibly some confusion arises because of the great variety and complexity of methods and materials offered, but more probably it is that the information given them is incorrect and founded upon wrong concepts.

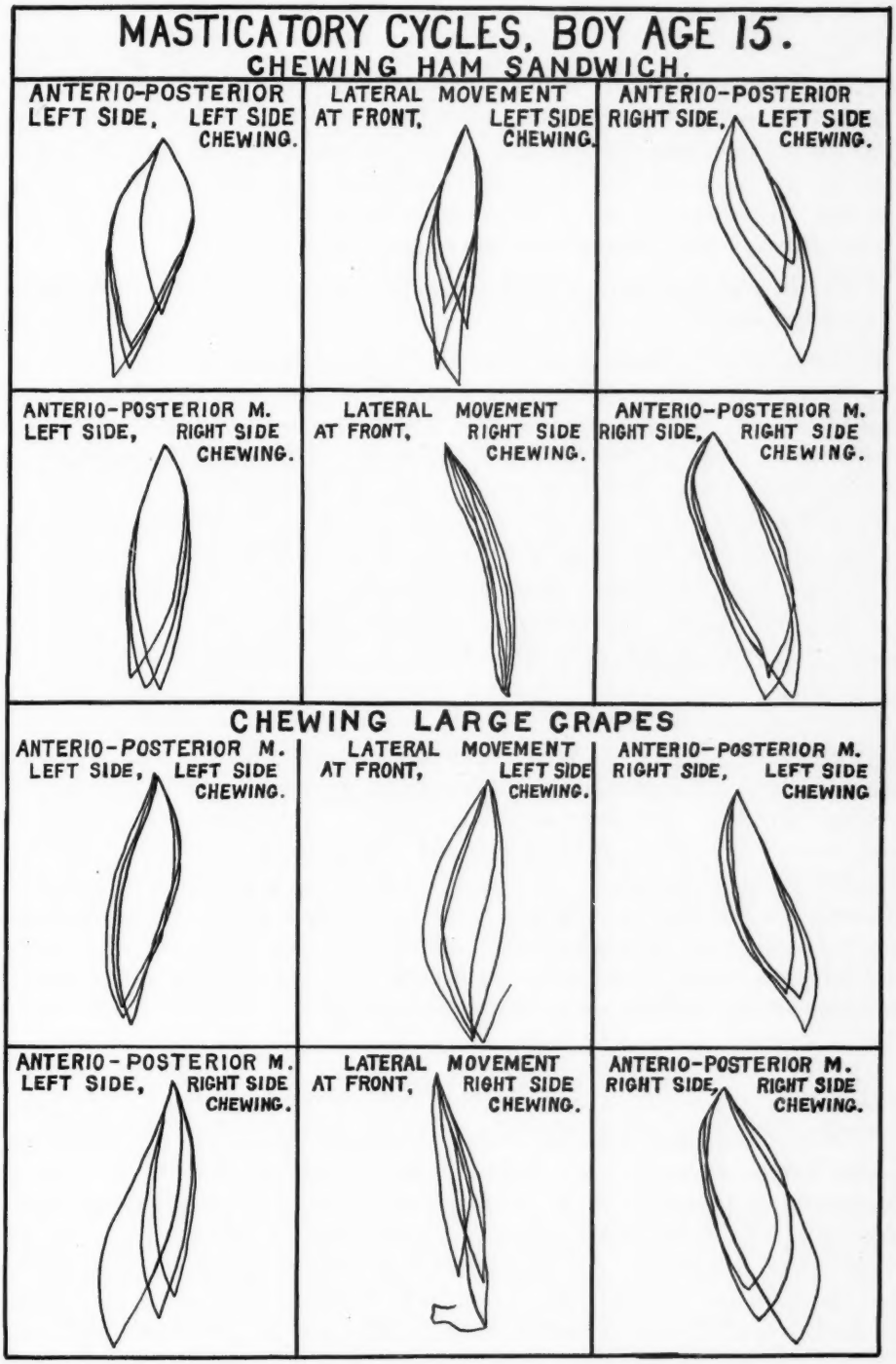

MASTICATORY CYCLES, BOY AGE 15.
CHEWING HAM SANDWICH.
ANTERIO-POSTERIOR LEFT SIDE, LEFT SIDE CHEWING.
LATERAL MOVEMENT AT FRONT, LEFT SIDE CHEWING.
ANTERIO-POSTERIOR RIGHT SIDE, LEFT SIDE CHEWING.
ANTERIO-POSTERIOR M. LEFT SIDE, RIGHT SIDE CHEWING.
LATERAL MOVEMENT AT FRONT, RIGHT SIDE CHEWING.
ANTERIO-POSTERIOR M. RIGHT SIDE, RIGHT SIDE CHEWING.
CHEWING LARGE GRAPES
ANTERIO-POSTERIOR M. LEFT SIDE, LEFT SIDE CHEWING.
LATERAL MOVEMENT AT FRONT, LEFT SIDE CHEWING.
ANTERIO-POSTERIOR M. RIGHT SIDE, LEFT SIDE CHEWING
ANTERIO-POSTERIOR M. LEFT SIDE, RIGHT SIDE CHEWING.
LATERAL MOVEMENT AT FRONT, RIGHT SIDE CHEWING.
ANTERIO-POSTERIOR M. RIGHT SIDE, RIGHT SIDE CHEWING.

Fig. 2.—Example of some functional mandibular tracings of jaw movements. Note there was no stroke in occlusion, the cycles having their termini at centric occlusion.

What has all of this to do with the subject, Practical Occlusion?

Simply this—the premises and concepts of many writers and lecturers, teachers, and other leaders in the profession's thinking have been based upon "handed down" theories regarding condylar guidances and balanced occlusions. This has led them into overemphasis of the importance of condylar path registration, the use of complicated articulating machinery, etc., with neglect of study of the real physiologic action of the mandibular mechanism, as indicated in its cyclic movement and masticatory strokes (Figs. 1 and 2).

Kurth, Craddock, and others have called attention to the fallacy of dependence in those concepts.

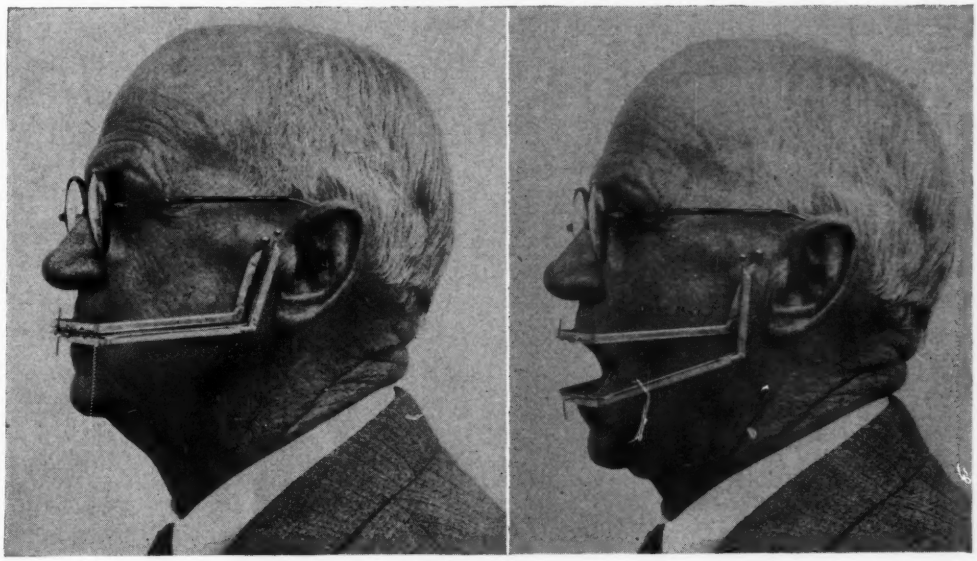
Kurth,[3] when discussing the physiology of mandibular movement, said: "It is to be regretted that the early investigators broke down the cycle of mandibular movement into its various components, and made an individual study of each, rather than the end result as a masticatory stroke which is a fusion of these various muscular efforts. These theories were usually associated with some technique for prosthodontia. For instance, the Monson articulator and technique were based on the spherical theory of occlusion, while Gysi's articulator had its foundation in his study of the lateral components of mastication."

Craddock[4] said: "For some years the indiscriminate use of mathematical and geometric symbols in this field, coupled with an admiration for, and preoccupation with the undoubted precision of many articulators, has injected into professional thinking on condylar guidance a degree of precision which fortunately perhaps does not exist in fact."——"It is not for one moment disputed that workers who use individual measurements of condyle path inclination and adaptable articulators produce prosthetic occlusions of great accuracy. What is here denied is that such records contribute anything essential to the excellence of the result."——"Especially in studying the dynamics of occlusion is it to be hoped that orthodontists and periodontists will pay more heed than have the prosthodontists to the fact that a point is reached in all technical procedures including that of making dentures, where the quest for further efficiency results in an elaboration and complication out of all proportion to the gain secured."

ERRORS IN ASSUMPTIONS

It is obvious that both earlier and later investigators have mistakenly interpreted purely anatomic and privilege action of the mandible to be functional movement, and have failed to recognize the cyclic or truly physiologic action. Thus, they have founded their techniques upon condylar guidance in error. Condylar action is really an accommodation, not a directing action. Condyle path records made and depended upon are usually obtained with the mandibles limited by fixation to an arbitrarily predetermined pattern, and are prevented from making free movement. The mandible when unbound has a wide range of free movement. It does have some limitation because of its "two joint" form, yet through the very nature of the joints there is permitted a wide range of movement. The forms

of the condyles, capsular ligaments, and of the articular discs are all of such nature as to permit great freedom of condylar action in adaptability for compensation. The temporomandibular joint has the freest range of movement of any of the body joints. The condyles are permitted to move to and fro about, and around, within their sockets either in straight or curved lines, and, to a considerable extent, with differences of simultaneous positioning in their respective fossae, right and left as each has need.



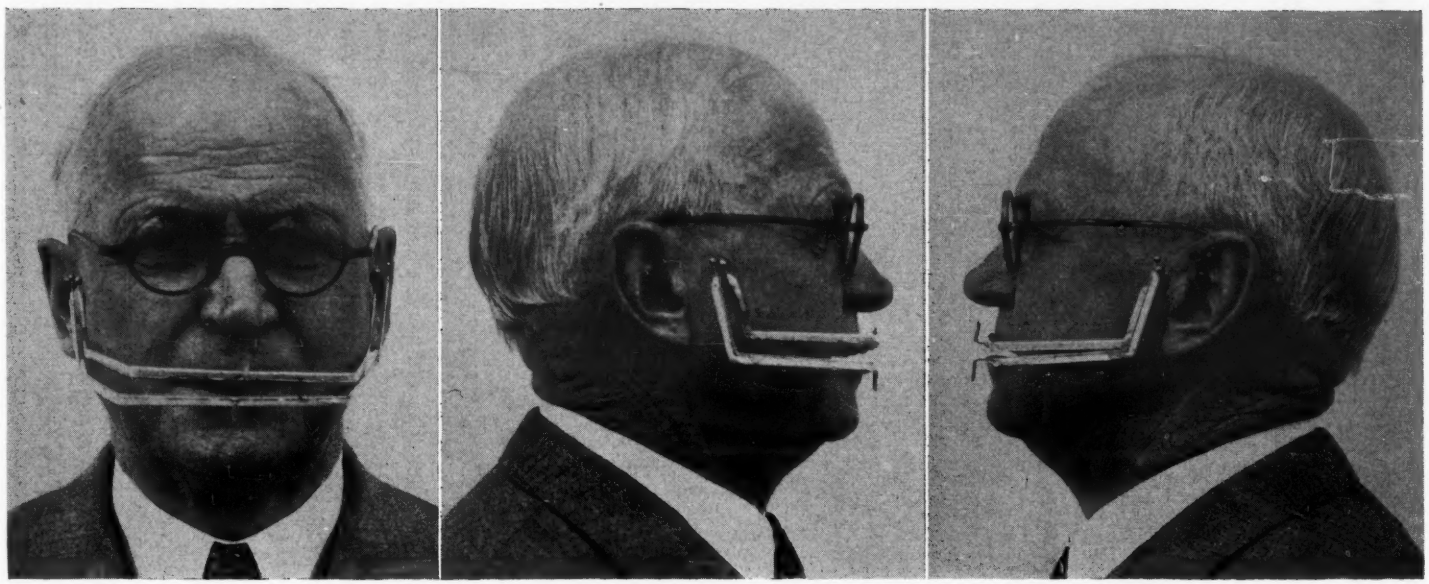
A. *B.*

Fig. 3.—Mandibuloscope. An instrument for the observation and study of free mandibular masticatory action. The small ball represents condyle movement and positions. *A*, Occluded position. *B*, Maximal opened position.

Just at the moment when the teeth may become unlocked from occlusion the mandible enters into its privilege of free action and can move to and from most any other point within its maximal range without return to any other particular point—not even to such an important point as the physiologic rest position. Even at its maximal opened position the mandible can move laterally if combined with some closing movement (Fig. 3).

We hold, therefore, that a record of condyle path movement is not one of condylar guidance, but is one of response to limitation, and can have no value when the mandible moves to any other position.

Sicher[5] states: "——this free movement of the mandible is independent of the individual shape of the articulating surfaces of the temporomandibular joint, especially of the inclination of the posterior slope of the articular tubercle." "Only if any point of the mandible becomes fixed does the movement of another point or



A. *B.* *C.*

Fig. 4.—Mandibuloscope with the morsel placed on the right side. Note the different condyle positional relations, and the paralleling of the occlusal lines for efficiency. *A*, Front view. *B*, Right (working) side. *C*, Left side.

points become dependent upon the two factors, the inclination of the plane which has been fixed arbitrarily, and the inclination and shape of the temporal articulating surfaces."

Mandibular action and guidance, then, are almost wholly neuromuscular, while the temporomandibular joints are primarily accommodative or adaptive mechanisms for assisting or fitting the body of the mandible with its teeth masses to its work (Fig. 4).

True physiologic movements are those made in the functioning of unfettered mandibles, primarily in the masticatory processes of incision, chewing, swallowing, and otherwise in nonmasticatory actions of talking, yawning, coughing, sneezing, whistling, etc.

Since those movements produce their effects in positions separate and apart from occlusion, and before that position has been reached, how can we expect it to operate in the balancing of dentures in any other position than centric occlusion?

OCCLUSION

McMillan[6] said: "Dental science is founded for the most part on occlusion." Waugh[7] said: "Normal occlusion is the basis of the practice of dentistry." La Due[8] said: "Balanced occlusion is the most important factor in full denture construction." Just what is occlusion, normal occlusion, or balanced occlusion that it should be so important?

Several years ago a prominent man gave this definition, "Occlusion in its broader meaning may be termed the closure maintained by the mandibular and maxillary dentures not only in static centric relationship, but throughout the full range of mandibular movements incident to the masticatory function." The *American Illustrated Medical Dictionary,* by Dorland, offers this definition: "Occlusion, Dental. The contact of the teeth of both jaws when closed, or during those excursive movements of the mandible which are essential to the function of mastication."

These definitions present the more commonly understood and accepted ideas of dental occlusion, particularly that of balanced occlusion, notwithstanding their foundation upon erroneous concepts of physiologic or functional masticatory movements. Also, in them we find the absence of a truth presented in the classic statement of Prime, "enter bolus, exit balanced occlusion."

The subject, "Practical Occlusion," suggests that there may be forms of occlusion which may not be practical, and it is our purpose to see if that is true. In our investigation we must not be deceived and overlook the fact that accommodative processes of nature enable some subjects to overcome certain obstacles, and permit them to become accustomed to things not perfect, so that wearing of dentures made with differing techniques is possible.

Broadly speaking, it may be said that dentures may have balance in occlusion just as defined above, yet fail to have denture balance against disturbing forces when in physiologic action; while others not having full-range occlusal balance of that form may have excellent denture balance in function through another plan.

MUSCLE BALANCE

The balancing of dentures must in reality be accomplished before occlusion (tooth contact) has been reached. The position of occlusion provides only the terminal base for masticatory strokes. It is reached too late for balancing against the disturbing directional and power forces which have been effective upon them long before. It must be effected through muscle coordination and the positioning of the condyles against the articular eminences, while the mandibular teeth masses are moving in the masticatory stroke of the physiologic cycle toward the ending at occlusion.

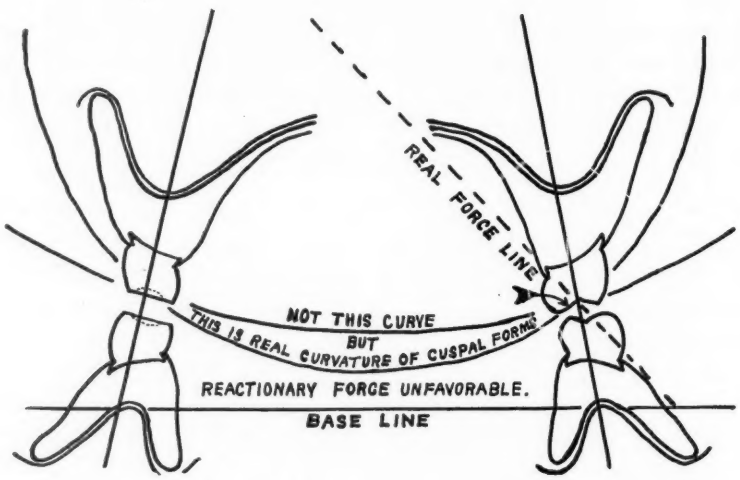


Fig. 5.—True curvatures and lines of directional and reactionary forces when there is a spherical form of occlusal arrangement.

Sicher[9] explains it thus: "The muscle balance during the second phase (meaning the closing movement) is of greatest importance, because the closing movement occurs under great force while the teeth, not yet in contact, cannot stabilize the position of the mandible. The powerful holding force of the external pterygoid is necessary to prevent displacement of the mandible while its condyle is precariously balanced by the disc on the posterior slope of the articular eminence."

But even the condyles may not be absolutely necessary for masticatory function, other than affording places of attachment of the valuable external pterygoid muscles with their action for protraction, etc. Evidence of this is found in cases of their resection, or accidental loss, as when in war some soldiers may suffer loss of the condyles, and in other cases when subjects have had permanent dislocations in early life, etc. A number of such cases have been known to this author.

Categorically, it may be said that there are three general forms of occlusal arrangement. The first is one generally taught in colleges, dental society lecture rooms, commonly practiced in dental offices, and for which most related products such as instruments and teeth for prosthesis are prepared (Fig. 5).

SPHERICAL FORM OF OCCLUSION

The spherical form of occlusion is commonly on a four-inch radius. It is sometimes referred to as having a Monson curve (Figs. 5 and 8). This occlusion must be developed in curved form, the arc plane having its convex face downward and its concave face upward. It must be arranged with so-called Spee and lateral compensation curvatures.

Those very curvatures create displacing elements, and for balancing dentures in function such form is illusory because of several basic errors.

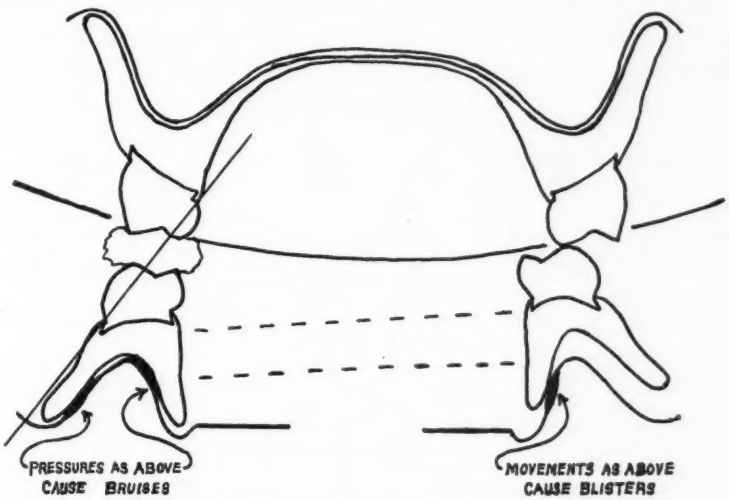


Fig. 6.—When the reactionary force from the upper denture is delivered outwardly, there is a resultant pressure upon one side only. This produces a tipping of the denture with bruising upon that side, and up and down friction sores upon the other side.

First of all, it is illusory because such occlusion is not "the relationship of the mandibular and maxillary dentures throughout their range of masticatory function," but is merely their relationship when in range of the plane or base created and predetermined in but one vertical dimension position as stopping places for the masticatory functional strokes. Before that point of occlusal balance has been reached, displacing forces in many directions will have already disturbed the denture balance in other positions and vertical dimensions. Occlusion cannot balance against the forces which have acted previous to the contact of teeth. Occlusion is synonymous with contact, whereas function takes place in the interval in which the teeth are mashing or passing through the food before contact (Fig. 6).

Then, to achieve this form of balanced occlusion one must master some precision technique requiring both precision instruments and considerable skill which is possessed by few. In every step there comes liability and probability of errors in registration and transposition. Not yet has any man invented an instrument capable of recording true physiologic movements of the mandible suitable for tech-

nologic usage. Not yet has anyone produced an articulator mechanism which in any way matches the human jaw and its movements, and to which records, so multifarious in each individual case, could be transposed and successfully used.

Even if balanced occlusion of this sort might be provided for, having spherical form, it would make for the occlusal surfaces of the upper posterior teeth to have outward-downward inclination. Thus, they would present buttresses with exceedingly strong resistance to the upward-inward masticatory strokes of the mandibular denture, and in return deliver equally strong opposing forces downward-outwardly against the lower denture at its working side only, with tipping, resorption, and other undesirable consequences (Fig. 7, *A* and *B*). It certainly and surely would provide for the deliverance adversely and destructively to the balance of the forces of the primary factors of mechanics, the inclined plane, and lever actions.

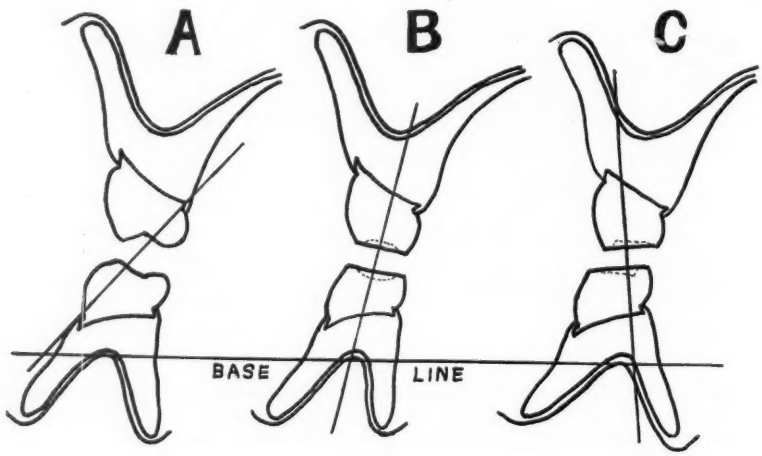


Fig. 7.—Reactionary forces may be favorable or unfavorable depending upon the form and arrangement of the posterior teeth. Note the angles of force lines in relation to the base line. *A*, Spherical form of occlusion, very unfavorable. *B*, Horizontal form of occlusion, less unfavorable considering the direction of force, but very bad in its direct butting action, *C*, Reverse pitch occlusal form, best form, because of the more favorable direction of the reactionary force, and the slide movement of food between the teeth.

The spherical form of occlusion also tends to magnify the stresses created, because the forces delivered somewhat at right angles to the occlusal surfaces are of butting action, whereas it is more advisable to have dragging, rolling, or shearing action to produce less stress. The forces against the lower denture are not only exerted in such a direction as to tip it, but will drive it to one side against the poorly formed and sensitive tissues of the mylohyoid ridge.

Artificial dentures are purely mechanical devices which are definitely responsive to the mechanical principles of nature. It is possible, by changing directions of the applied forces and lessening their magnitude, to have dentures use these mechanical principles beneficially instead of harmfully.

HORIZONTAL FORM OF OCCLUSION

A second type of occlusal balance is one wherein the occlusal plane is of a horizontal form, and with the principal design of the lower posterior teeth having that same form. The lower teeth are set well up over the crest of the ridge, or even slightly lingual to its crest. A corresponding form and arrangement of the upper posterior teeth is used. By this method it is intended to direct the resultant masticatory forces from the maxillary denture on the working side vertically downward and have them fall lingual to the lower posterior ridge. The forces being applied well within the ridge foundations of each working side divide pressures, and thus obtain stability and lessen traumatic effects.

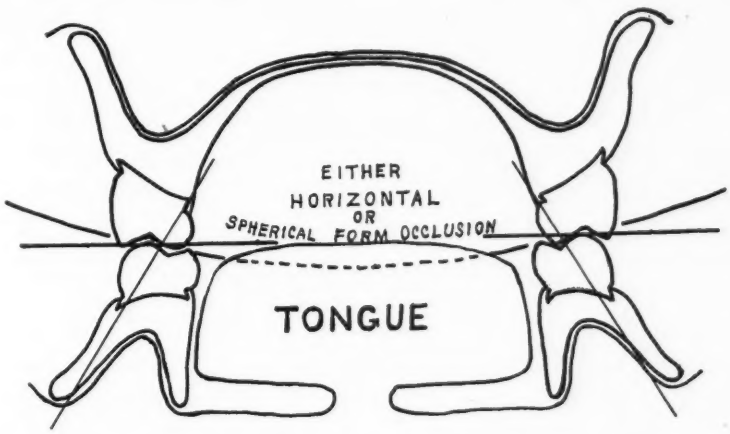


Fig. 8.—The lower denture is forced laterally by pressure on one side. Tongue space is limited, and when it is resting under the denture flanges, the tongue becomes a factor in lifting the lower denture.

This form of occlusion, while better than that of the spherical form, has its shortcomings in both theory and practice. The horizontal arrangement, while providing for deliverance of the masticatory forces at a much less acute angle to the foundation base line, does permit of some such angle of direction. This is enough to result in a tendency for tipping and excessive working side pressures because of the true direction of the powerful masticatory stroke. Part of the cycle of normal physiologic action of the mandible is in an inward and upward direction with a consequential downward and outward force applied to the lower, and is not applied in a purely vertical direction. It is very difficult to deliberately change the mandibular stroke from its natural inward and upward direction to one of a strictly vertical direction.

If the teeth are set somewhat lingually so as to try to promote stability through vertical forces, tongue space becomes limited. Not only does it become a fault by reason of lack of space, but also there is usually given to the inner or lingual posterior section of the denture base and teeth a form permitting the tongue to lie below the base, and act as a lifter instead of being helpful as a retainer (Fig. 8).

The horizontal occlusal form stands with its virtues between those of the spherical form and a third type of occlusal form which is believed to be best.

REVERSE PITCH OCCLUSAL FORM

A most practical form of occlusion may be referred to correctly as a reverse pitch occlusion, in which the occlusal surfaces of the posterior teeth are inclined obliquely upward, from their buccal to their lingual borders. With this inclination the primary principles of mechanics, namely, the inclined plane and the lever, are used in such manner as to be productive of dentures which have masticating efficiency, with a minimum of disturbing stresses, and altogether less harmful effects upon supporting structures (Fig. 9). The idea first came to our attention in 1929 and 1930 in articles by Avery and Avery.[10]

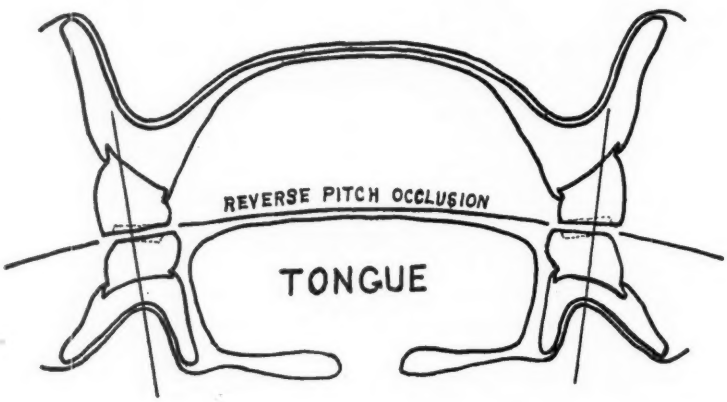


Fig. 9.—The lower denture is stabilized more evenly throughout the whole area of its base and foundation by pressure from the upper denture. The tongue space is greater, and the tongue, lying above the lingual flanges, aids in the retention of the denture.

In the formation of the reverse pitch occlusal form, attention is given to the fact apparent—that we can and must use natural forces attendant upon masticatory function for the proper fixation of dentures, with the resultant serviceability and comfort to patients.

The masticatory stroke which is composed of the last two phases of the physiologic cycle of mandibular movement is one of great power. To use its forces favorably requires an understanding of the really free, unforced, and undirected movements of the mandible, and a recognition of the forces resultant in and from those movements. It requires the application of this knowledge toward changing disturbing elements into beneficial elements.

These ends are accomplished by deliberately avoiding the arrangement of the teeth in a spherical form, either with a template, "ground in" occlusion rims, or any other plan of producing that form. Instead the posterior teeth are set arbitrarily in such a position as to have the buccolingual occlusal plane pitch slightly higher

at the lingual than at the buccal borders. The inwardly inclined planes then presented by the occlu al surfaces of the upper posterior teeth will deliver their strong forces against the corresponding buccally inclined planes of the occlusal surfaces of the lower posterior teeth, in an inward direction, instead of an outward direction, as is done with the spherical occlusal form. Forces are in this way directed to fall upon the better formed and more tolerant tissues of the mandible outside the ridge crest, instead of upon those more sensitive tissues of the poorly formed mylohyoid and mouth floor regions. The lower denture will be stabilized by masticatory functional forces, and will have a supporting foundation throughout its entire base, instead of under a small area of its working side only.

The reverse pitch occlusal form is basically a unilateral balance form. Man, like most lower animals, is a unilateral chewer, and has need for bilateral balance only in centric occlusion at the end of masticatory strokes, sometimes when swallowing, occasionally to seat the dentures, or, as in case of denture nervous persons, to be a "play" occlusion.

With this occlusal form, it is possible, practical, and advisable to set the posterior teeth slightly outside the mandibular ridge, thereby affording tongue space as well as making a better form of the lower denture for tongue aid in retention of that denture (Fig. 9).

IMPORTANCE OF UPPER FORM

One should understand that the upper denture, because of its form and firmness of seating, is primarily responsible for success or failure of the lower denture balance and, therefore, must have a proper form for the production of rightly directed reflex masticatory force. It should have posterior teeth with inwardly inclined occlusal face planes. The reflex or reactionary forces will originate on these planes of the upper teeth, and be projected in the proper direction upon the occlusal planes of the lower posterior teeth.

OCCLUSAL BALANCES

Dentures must first be balanced, as suggested in previous paragraphs, with respect to the physiologic or masticatory movements and forces, so multitudinous, so variable, and strong. After that, consideration shall be given to promotion of certain occlusal balances. These are four in number, each independent of the others, and relatively easy to obtain in the mouth at time of "try in."

Two of these balances are bilateral. The first is centric or near centric position balance. It does not appear that positive pin-point centric relation is essential, though one should not expect success if centric occlusion is too remote from it, in most cases. We see many people, however, some with natural dentures, others with substitute dentures, and some with no dentures at all, who have developed a more comfortable and yet powerful eccentric positional functional occlusion, to let us believe that the positive centric occlusion is absolutely required. We have had experience with patients whose occlusion could not be acceptably returned from an eccentric functional position occlusion to centric occlusion, especially with-

out long, painful effort. Boos[11] found that in about 32 per cent of cases examined and measured the greatest biting force was in an eccentric functional relation. Some such cases, although showing some improvement, had not returned to the normal centric relation in a period of two years.

The second bilateral balance is in the incisive or protrusive positions. In some cases a three-point balance (not always necessary) is developed. This may be obtained by elevating the distal ends of the lower second molars so they move into occlusion with the two upper first molars when the mandible is moved forward into incisive or biting position. In this position the bicuspids and lower first molars are usually cleared of occlusion. This three-point balance may also be formed by lowering the lower denture incisors and cupids to take them away from occlusion with the upper incisors. The incisive or protrusive balance is not necessary in cases of extreme recessive mandibular occlusion, or in extreme infra-occlusion.

Right and left eccentric position balances are unilateral balances, and are easily obtained in each lateral position. Only three upper and three lower occluding teeth are involved, and they are easily adjusted. The two bicuspids and first molar of each denture upon the side being balanced are considered alone. The corresponding teeth of the opposite side of the arch being cleared of occlusion may be ignored until the operator turns to that side for their balancing and he may then ignore the side first arranged. The upper second molars are raised slightly out of occlusion and in very close cases may be left out entirely.

The technique described may be used in most cases, especially those in which it is desirable to give mechanical advantage to the lower denture. For some cases in which the upper foundation is very unfavorable because of smallness, softness, or extreme narrowness, in which the reverse pitch occlusion even in cross bite might seem to be impractical, the horizontal plane, or "Monson curve" occlusion form might be advisable.

The reverse occlusal pitch technique is simple, and becomes easy after one has learned that the fundamental principle is to use the forces resultant from masticatory movements and powers by properly directing them for service and retention.

TECHNIQUE

There is required a slight modification of the forms of available teeth, for most of these are made for use in the spherical occlusal arrangement, and must be ground for adaptation to the reverse occlusal pitch arrangement.

Beginning with the uppers, modify the biscuspids and first molars by grinding the small amount from the lingual cuspal points to make a straight plane, without obstruction, from the buccal edge to the lingual edge of the occlusal surface of each tooth. Then set these with an inclination slightly higher at the lingual side. This will produce an inclined plane which will direct the resultant force inwardly toward the lower lingual and not outwardly toward the buccal.

The lower teeth must be matched to this form of the upper, and this requires the removal of the buccal cuspal prominences of the lower bicuspids and first

molar, leaving lingual cuspal sections to stand higher than the buccal when finished, in a plane to match the upper occlusal plane.

The upper and lower second molars are used without grinding and set in the usual way. The uppers are inclined slightly toward the buccal, and the lowers are inclined slightly toward the lingual. This is to prevent some interferences which would occur if they were set in reverse.

The final finishing after processing is done in the mouth to make the occlusion smooth (usually this is preceded by a little spot grinding with stones). A paste is used of ordinary glass finishing emery and water. The patient must be required to chew with movements typical of mastication, and *not* to grind with excursive occlusal movement.

This smoothing of the occlusion is usually done a few days after their first insertion, in order to allow for a little settling of the dentures first, because in our experience dentures do make a slight change in position through settling. In the case of immediate denture restorations, it may be necessary to postpone the smoothing of the occlusion longer because of the attendant discomfort to the patient.

REFERENCES

1. Boyle, Horace H.: On Lever Action of the Mandible (Excerpt), J.A.D.A. **39**:745, 1949.
2. Young, Harry A.: Diagnosis of Problems in Complete Denture Prosthesis, J.A.D.A. **39**:185, 1949.
3. Kurth, LeRoy E.: The Physiology of Mandibular Movement Related to Prosthodontia, New York State Dental Journal **15**:323, 1949.
4. Craddock, F. W.: The Accuracy and Practical Value of Records of Condyle Path Inclination, J.A.D.A. **38**:697, 1949.
5. Sicher, Harry: Oral Anatomy, St. Louis, 1949, The C. V. Mosby Co., p. 172.
6. McMillan, H. W.: Unilateral vs. Bilateral Balanced Occlusion, J.A.D.A. **17**:1207, 1930.
7. Waugh, L. M: Normal Occlusion Basis of Practice of Dentistry, Dental Cosmos **57**:862, 1915.
8. LaDue, John B.: Occlusion in Full Denture Construction, Dental Survey **25**:1619, 1949.
9. Sicher, Harry: Oral Anatomy, St. Louis, 1949, The C. V. Mosby Co., p. 177.
10. Avery, S. K., and Avery, B. W.: Scissor Bite Technic, Dental Digest **35**:353, 1929; J.A.D.A. **17**:1303, 1930.
11. Boas, Ralph H.: Centric and Functional Bite Relations, J.A.D.A. **30**:262, 1943.

823 Woodruff Building
Springfield, Mo.

A STUDY OF POSTERIOR OCCLUSION IN DUPLICATE DENTURES

S. Howard Payne, D.D.S.

Professor of Prosthetic Dentistry, University of Buffalo, College of Dentistry, Buffalo, N. Y.

FOR the past several years there has existed a state of confusion as to the status of denture teeth. Some will argue at great length on the merits of the anatomic or 33 degree tooth; others are just as vehement in their defense of the flat or mechanical tooth. More recently, new carvings have been developed which seem to be the illegitimate offspring of the other extremes. That is, they have small cusps, but the cusp angles and prominences have been reduced.

To add to the difficulty, we have articulators from the 25¢ hinge to the $2800 gnathoscope in all sizes, shapes, and adjustments. Everybody is trying to build a better set of dentures in a different way.

We have been taught for years that the guiding factors of the mandible were the condyles and the teeth, and those of us diligent enough to follow the rules of the masters carefully utilized the laws of articulation, and with studious perseverance worked out the movements and the necessary balance in the articulation of anatomic teeth.

This study is being undertaken to clarify some of these confusing elements in the minds of the students and general practitioners. Whether or not such clarification is possible will not be known for a while.

Ideally, perhaps, several types of posterior teeth should be used in duplicate dentures for the same patient, to test their efficiency. These tests should be repeated in many individuals.

Because of the time factor, ridge changes, and the appalling task of getting used to eight or ten sets of dentures in a relatively short time, this idea was discarded. Instead, it was decided to make two sets of dentures for each patient using 33 degree teeth on one, and mechanical teeth on the other. A standardized technique was used in impressions from which duplicate casts were made. Interchangeable baseplates were adapted, and the centric registration was taken with a needle point tracing. A kinematic face-bow was used to locate the condyle heads, and then the conventional face-bow was used to transfer the maxillo-condylar relationship to the Hanau articulator. The lower cast was next mounted on the articulator in relation to the upper, using the baseplates sealed in centric position according to the gothic arch tracing. Now the second lower cast was mounted on

Read before the Academy of Denture Prosthetics at Milwaukee, Wis., May, 1950.
Received for publication Jan. 15, 1951.

a new ring in centric relation to the first upper cast. Subsequently, the second upper cast was mounted in centric relation to the second lower cast. Each mounting duplicated the other. Anterior teeth were set up to have the same appearance in both cases. Then, flat posterior teeth were used on one set of dentures, and 33 degree posterior teeth on the other. The height of the occlusal plane was duplicated as far as possible. Motion pictures were made of the first case for a permanent record of the procedure.

Miss B., a 15-year-old girl, was chosen for the first patient because:

1. She was losing almost a full complement of teeth. This means that she would have more nearly normal chewing habits, and less pathology of the masticating mechanism than experienced denture wearers.
2. She could get used to the dentures more quickly than an older person.
3. Her replies to questions would not be colored by past experiences with other dentures, inasmuch as these were her first ones.

When the completed dentures were finished, a plaster check bite was taken in the mouth with each set, the cases were remounted, spot ground, and milled. She was given the dentures with the flat teeth first, and was recalled after twenty-two hours of continuous wear, then again in ten days. Upon questioning, she stated that "she could eat everything she tried;" i.e., sliced baloney, potatoes, bread, and butter. She had the most difficulty with the bread. Only two sore spots were present during the first two weeks that she wore this set.

Then the dentures with the cusp teeth were issued and she wore this set for two weeks. Only one sore spot was duplicated. In this case the soreness factor was not significant.

We asked the patient next to wear the dentures on alternate days for one week, and finally to use both sets at the same meal when possible and make notes on the efficiency. The following are excerpts from these notes:

Bread—"Flat teeth leave food chunky, cusp teeth do not."
Candy bar, carmel center—"Flat teeth bite not too good, cusp teeth better."
Celery—"Flat teeth all right, cusp teeth better."
Hard cookie—"With the flat teeth liquid was needed, the cusp teeth ground the cookie up without it."
Steak—"Flats chew well but meat remained stringy, cusps were good."
Sandwich—"The flats do all right but still is difficult to chew bread. No trouble with the cusp teeth."

At the conclusion of this time interval the following tests were made. Using a small wire frame to which a pencil was attached, and then sealing this frame to the lower denture, tracings were made of lateral free movements, lateral movements with the flat posteriors, and with the 33 degree teeth. (See Fig. 1.)

It is apparent that the mandible moves in an upward arc in this patient while it changes to a flat line with the flat teeth, and to an inverted flat "V" with the

anatomic teeth. A similar inverted "V" is made in a normally occluded set of natural teeth. Here, then, is a situation in which physiologically the mandibular movements with teeth are not at all like the same movements without teeth. And from these tracings it is apparent also that the mandible follows with some close degree of exactness the occlusal surfaces of the teeth which are present in the mouth. If, then, the mandible will follow high cusps or low cusps, or no cusps, we might easily come to the conclusion that the teeth are the sole guiding factors of the mandible, and that the condyles are not guiding influences.

Fig. 1.

Let us leave this discussion momentarily and go to the chewing tests. For these, three food items were chosen: Pressed ham, raw carrots, and peanuts. Miss B. was allowed to chew each of these separately, and the number of chewing strokes was counted until she swallowed each item, respectively. The number of strokes required before swallowing averaged as follows:

Raw carrots, 3 slices	20 strokes
Pressed ham, 2″ square	9 strokes
Peanuts (5)	15 strokes

Using approximately one-half of the total strokes, respectively, each food item was chewed with the flat teeth and expectorated into a plate. Then the anatomic teeth were used and the procedure was duplicated exactly.

Tracings were made of the chewing cycle with each set, chewing each food item the same number of strokes as with the other dentures. There was no doubt as to the comparable efficiency of the two types of teeth. The food chewed with the anatomic teeth was ground up much better than that with the others. Although the shapes of the tracings of these movements were naturally different, the centric position was always reached exactly. There seemed to be more of a chopping stroke with the anatomic than with the flat cusp teeth. The meat required the least lateral excursion, and the carrots the most. (See Fig. 2.)

The width and length of the chewing cycle depends, as we can see, on the amount of bulk of the bolus and the relative difficulty in keeping it on the lower food table.

We have been able to determine that the mandible returns to centric position at the conclusion of the chewing stroke. We have demonstrated also that the mandible will follow either flat planes or cusp inclinations in lateral movements. Is it reasonable to say that, with an accurate centric registration, we can now set our teeth any old way on any old instruments? This is a dangerous conclusion to set before a group of practicing dentists, because it seems to be a short cut.

The trouble with short cuts is that they require much more accuracy, not less than proved procedures, even if they are practical.

Assume for the moment that this latitude in eccentric movements is normal; that we can expect the mandible to follow any occlusal pattern that we build. The ligaments of the temporomandibular joint are flexible and because the condylar head does not fill the glenoid fossa, it will move about in all planes in space. How, then, is centric such a precise position that it can be designated with a needle point? Certainly there is little latitude here. So, within what range can we tolerate malocclusion? Many joint symptoms have been alleviated by judicious equilibration of the occlusion in natural teeth. Other individuals with mouth conditions just as bad develop no symptoms. The same is true of the artificial dentition. The tolerance of the individual differs greatly. The amount of latitude in the joint, and its ability to adapt to the specifications of artificial dentures must of necessity be different in individuals.

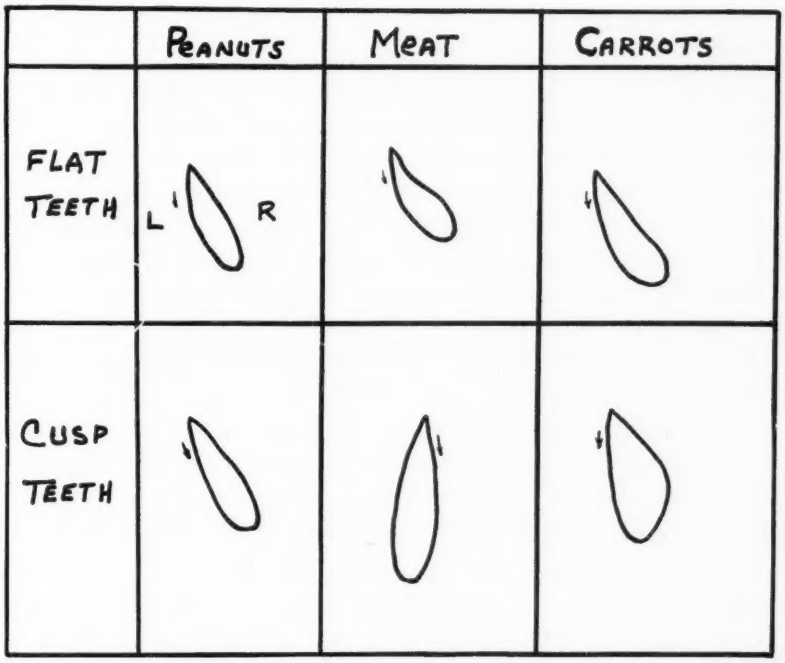


Fig. 2.

The fact that the mandible will follow different cusp inclinations within certain limits, to me, does not mean that we can throw away all adaptable instruments. It is true that the free movements of the mandible are extensive and varied, but once the anterior teeth are set up we have imposed restrictions on these movements by the limitations of the overbite and overjet and the shape of the glenoid fossa.

If we are working on a straight line articulator we must first set our posteriors intuitively and then use the mouth as an articulator, and check to see that the

occlusal scheme is harmonious in functional excursions. It is like sawing to a pencil line on a board, compared to using a miter box. The latter will hold us within limits and make the task much easier for the average individual. There is no doubt that many men with much experience can set up teeth with very little effort and have the dentures function well in the mouth. But there are many more who cannot. I feel that the majority of men can be much more accurate in the long run by utilizing all of the guiding factors on an adaptable articulator. Consistently, this will produce better clinical results in a cross section of individuals.

As to the efficiency of anatomic and flat posterior teeth in these chewing tests, the cusp teeth were demonstrated to be better. Until many more cases are completed, it would be foolish to make this a positive statement for all cases. It would seem, and Sicher has noted, that the more wear on posterior teeth, the more excursion of the mandible is used in chewing. This was corroborated in these tests. In so far as lateral cusp heights are concerned, it is a question of whether the component of lateral thrust introduced by the cusp is offset by the thrust on the flat tooth from increased jaw excursion. The patient cannot chop efficiently with flat teeth, so he must do more shearing and crushing.

However, the author and many others definitely feel that anteroposterior interlocking of cusps is detrimental to the functioning of artificial dentures. By this interlocking we impose a need for precision in recording centric registration which few can attain consistently, and we inadvertantly create potential malocclusion as soon as settling of the denture bases occurs. We firmly believe that the movement of the bases in order to interlock the teeth in their original position is one of the greatest single factors in excessive resorption of the ridges in individuals whose bone factors are low.

By opening up the central fossae of the anatomic lower posterior teeth after they have been set, and grinding down the tips of the buccal cusps of both upper and lower teeth, it is possible to eliminate this intercusping, and still retain most of the anatomy of the 33 degree teeth. The lingual cusps of the upper teeth glide in the central fossae of the lowers, and have a mortar and pestle effect. This is one possible solution to the problem.

SUMMARY

We know that the mandible will follow the occlusal pattern which we build with close exactness within certain limits. We know from past experience that the adaptability and tolerance of different individuals varies greatly. The efficiency of the types of posterior teeth also differs according to the types of food, the character and relationship of the jaws and their tissue coverings, and the adaptability of the individual. We must emphasize the importance of using better judgment and more care, not less, in order to make possible the construction of better dentures for our patients.

25 Goodrich Street
Buffalo, N.Y.

THE HINGE AXIS OF THE MANDIBLE

L. E. KURTH, D.D.S., AND I. K. FEINSTEIN, M.A.*

Chicago, Ill.

THE presence of a hinge axis or axis of rotation for the mandible in the primary phases of its opening movement has been debated in conjunction with its value in the clinical phases of dentistry. Some techniques have based their existence on the presence of such an axis. "In 1921, I became convinced that the opening and closing center of the mandible was a most important factor in dental articulation and that its determination was preliminary to the transferring to an articulating instrument a record of jaw relations". . . and we "have proved to our entire satisfaction that the teeth may be opened as much as one-half inch in the incisor region in every case, and in some cases as much as an inch, without compelling the condyle heads to move forward in the fossae, as happens in opening the mouth wide."[1] It is interesting to observe that all these techniques which subscribe to a hinge axis do not mathematically prove that the mandible moves on a hinge. A point of no movement can be found, but supporting scientific evidence to prove that this is the axis for a hinge movement is lacking. Witness the weak support to this theory as exemplified in this statement: "The hinge movement was disputed or overlooked. Since the hinge movement exists in every other joint in the body, it seems fantastic to concede that the mandible is without one."[2] Such highly illogical reasoning is hardly conducive to a scientific understanding of this subject. Other techniques have completely ignored the determination of the hinge axis in the various clinical steps. Higley[3] has described these controversies in a recent article. We decided to investigate the possibility of determining the hinge axis (if it exists) mathematically.

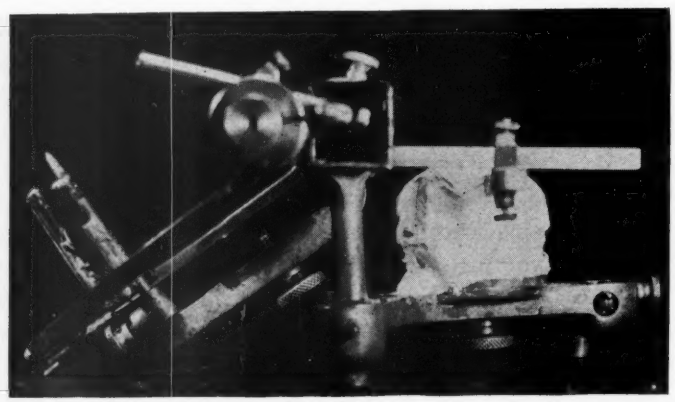
A detailed review of the anatomy of the temporomandibular articulation is not necessary in this article. Sicher,[4] in describing the temporomandibular joint, says that between the temporal bone and disc, the fibrous capsule is very loose to allow the extensive sliding movement in the upper compartment of the articulation. "Between the disc and mandibular condyle, however, the capsule is much tighter. Here, where only hinge movements occur, the capsule is especially tense between the disc and the two poles of the condyle." He further states that "the opening movement to bring the jaw from the occlusal to the rest position is almost a purely hinge movement."[5] Sicher says the adaptation of the disc to the head of the condyle by the capsular ligament is not entirely rigid, and there is some play in this area. It cannot be compared with a mechanical hinge joint,

Received for publication Feb. 6, 1951.

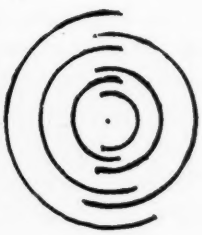
*Department of Mathematics, University of Illinois, Chicago Undergraduate Division.

such as one would find in an articulator. Because of the possible anatomic and psychological variables which may confuse the picture when a patient has to be instructed to perform a certain movement, we decided to eliminate these difficulties by using a Hanau articulator as the patient.

This articulator was modified by soldering a Gysi face-bow to the incisor pin of the instrument. The position of the condylar tracer of this face-bow can be altered in three dimensions by the operator. A tracing plate was rigidly attached by plaster to the lower member of the articulator, and so positioned that it would contact the tracer attached to the upper member in the region of the condyles of the instrument. The glass plate was covered with wax to enable the operator to trace and record the movement of the articulator when opened. The condylar adjustments were so set that the only movement allowed the upper bow of the articulator was rotatory, in a pure hinge movement.



A.



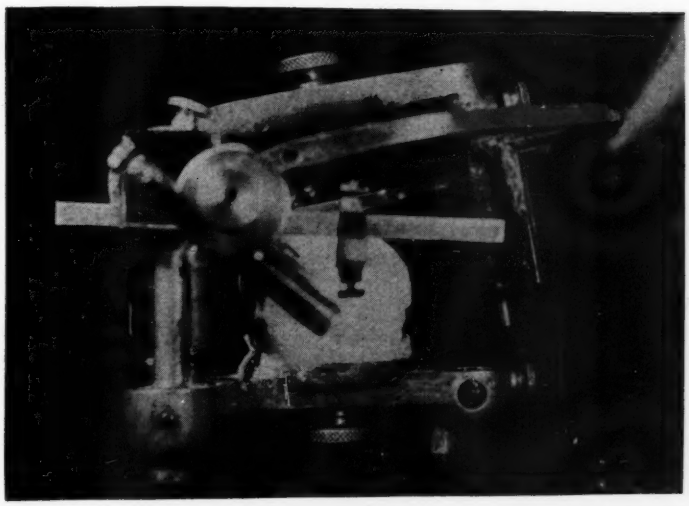
B.

Fig. 1.—Hanau articulator with Gysi face-bow attached to the incisor pin and the tracings made in the condylar region by raising and lowering the upper member of the articulator to its complete opening. Under these conditions only one point of no perceptible movement could be demonstrated, and that was located in the center of the condylar axis.

The tracer of the face-bow was set off the condylar axis to the limits allowed by the glass plate, and the articulator was opened to its fullest extent. An arc of a circle was thus traced on the waxed tracing plate, as shown in Fig. 1. The condylar tracer was then successively brought to different positions toward the articulator's axis, and other arcs were traced. This procedure was repeated until one position was reached where there was no apparent movement on the tracing plate when the incisor pin was opened to its fullest extent. This point was assumed to be the hinge axis for this instrument, and is in the center of the intercondylar rod of the articulator. Theoretically this point can be the only true geometric center, because of the fixed radius from the condylar region to the incisor pin of the instrument. Please remember that this instrument is far more accurate as a hinge than any patient's mandible, and that this point was located

by moving the upper member of the articulator through an arc of over 180 degrees. Such an experiment as the above cannot be performed by any human being, as it is anatomically impossible for the mandible to move through 180 degrees of space. The proponents of the hinge axis theory have shown that some patients open one and one-half inches in a pure hinge movement, but the average appears to be one-half to three-fourths of an inch, or about 11 degrees.

To ascertain what occurs when the articulator is opened only three-fourths of an inch, we performed a second experiment. Another glass plate was waxed and placed in the receptacle attached to the lower member of the articulator. The upper member was raised an amount sufficient for the incisor pin to clear the lower member of the articulator by three-fourths of an inch (Fig. 2). Many



A.

B.

Fig. 2.—Hanau articulator with Gysi face-bow attached to its upper member, and the tracings made in the condylar region by raising and lowering the upper member of the articulator three-fourths of an inch. Under these conditions it was found that within a 2 millimeter area many points of no perceptible movement could be traced in the vicinity of the center of the condylar axis.

centers in an area of about 2 mm. were found in the region of the condyles of the instrument which, by perception alone, could serve as centers of hinge movement. It was impossible to determine which one point was the true geometric center for hinge movement. When one considers that this same problem will occur in a patient when such a center is being located and the clinical value placed on the accurate positioning of this point, one can only question the assumption that a true hinge can be located in a patient in this manner.

We will now attempt a mathematical explanation of this phenomenon. For the purposes of explanation, we described an equilateral Bonwill triangle, using the centers of the head of each condyle and the incisor point as the vertices, and having four-inch legs. Then the leg connecting the heads of the condyle or

condylar cord is thus a segment of the hypothetical hinge axis. Since the altitude of an equilateral triangle is $\frac{\sqrt{3}}{2}$ times as great as a leg, the altitude of our Bonwill triangle is $2\sqrt{3}$ inches, or about 3.46 inches. This length would correspond to the radius of the arc which the incisor point would describe in a pure opening movement. To aid our experiment we constructed a wooden working model with the above dimensions, using a scale of two inches to one inch to magnify any errors which may be present. The notation used was as follows: point *A* corresponds to the incisor point in an occluded position; point *C* corresponds to the distobuccal cusp of the lower second molar; point *O* was geometrically constructed as the hinge of the system. Note that this working model introduces many more variables than in the case of the articulator previously described. There we were concerned principally with finding the hinge axis in the region of the condyle. In this working model, in addition to a hinge axis, we have inserted the cusps of the teeth as referred to the median sagittal plane, along with the curve of Spee. (See Fig. 3.)

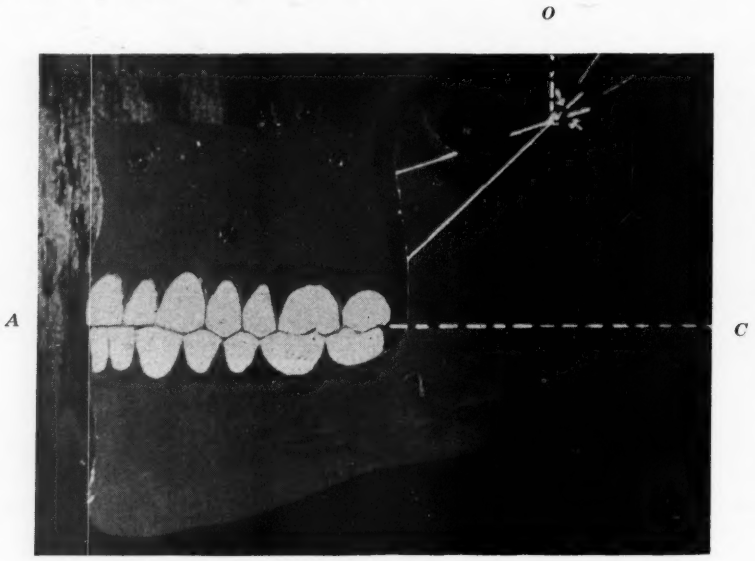


Fig. 3.—A wooden working model accurately constructed from the data obtained from an eight-inch Bonwill triangle, locating points described in the text.

If one other point could serve as an axis for the model, the notion of a single unique hinge axis could not be supported. We first opened the jaw in the working model to one and one-half inches (this corresponds to a three-fourth inch opening in the human jaw) using point *O* as the hinge axis. In Fig. 4 where the situation is diagrammed as follows: point *B* corresponds to the incisor point of the mandible opened to one and one-half inches (three-fourths of an inch in the human jaw); point *D* corresponds to the position of the distobuccal cusp of the lower second molar when the incisor point is at point *B*; L_1 is the

perpendicular bisector of the chord AB; and L_1 is the perpendicular bisector of the chord CD. Naturally, both of these bisectors pass through O. Obviously, for the jaw to return to its original geometric position, the radius OB and the point O must remain constant. However, if the jaw can return to what appears to be the original position by finding a point other than O as the center of rotation, then evidently the notion that one and only one point may serve as the location for the hinge axis is not tenable. (For the purposes of this discussion, the phrase "apparent occlusion" shall mean that the mandible has returned to what appears to be normal occlusion.) Furthermore, every point of the bisector L_1 may be used, by varying the radius, as a center of a circle on which the points A and B would lie. Similarly, every point on the bisector L_2 could serve as the

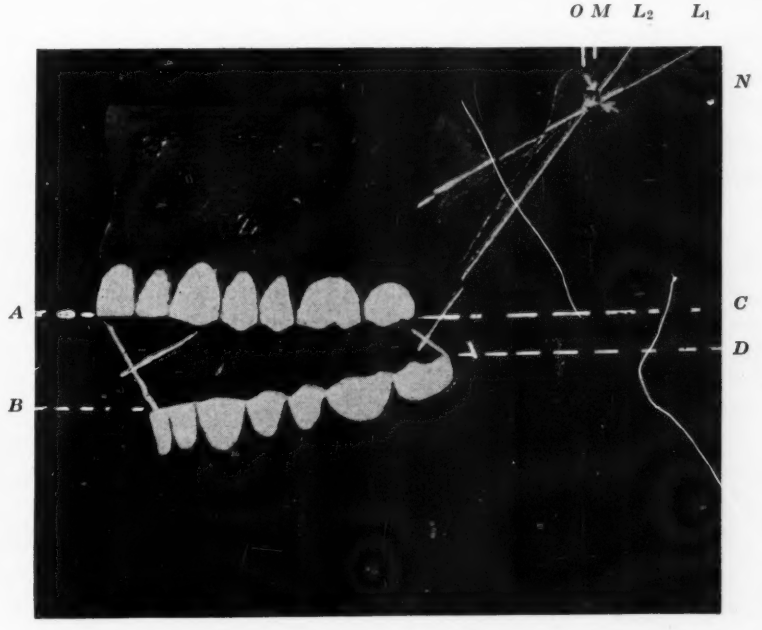


Fig. 4.—Model opened to one and one-half inches with bisectors for this opening demonstrated. The mandible can be returned to position shown in Fig. 3 by moving the axis from point *O* to either *M* or *N*.

center of a circle on which the points C and D would lie. However, in this discussion we are limited by anatomic considerations because the radius of the system is fixed. With the jaw in its open position (see Fig. 4) we drilled several holes in the vicinity of O and between L_1 and L_2. It was found that several of these holes would serve as centers for returning the jaw to apparent occlusion. Points M and N were two such points. The distance from O to M was 4.5 mm., and from O to N, 4 millimeters. As this model was constructed on a two to one basis, this distance divided by two would give approximately a 2 mm. area of non-movement. This area compares very favorably with that found in

the condylar region by the use of the articulator with a limited opening. More research will have to be accomplished to set these limits, as individual perception is the greatest factor in its delineation. However, we can conclude that since more than one point may serve as a hinge, the value of such a point in the clinical phases of dentistry is extremely questionable.

SUMMARY AND CONCLUSIONS

1. The presence or absence of a hinge axis of the mandible is of prime importance in some clinical phases of dentistry.

2. With the aid of an articulator and a working model, we have demonstrated that more than one point may serve as a hinge axis. Thus we conclude that an infinite number of points exist which may serve as hinge points.

3. It is unwise to predict the characteristic properties of a physical system merely from an examination of 1/35 of it, that is, by watching the side of the face as the jaw moves through an arc of only 10 or 11 degrees.

4. The determination of the hinge axis by mechanical or mathematical methods is doubtful without the supporting anatomic evidence of non-movement of the condyles.

5. It is most unlikely with all the variables operating in the case of the determination of the hinge point — perception, anatomy, physiology, the ability of the patient to follow instructions, the preconceived prejudices of the operator — that the hinge axis can be located with any degree of accuracy.

REFERENCES

1. McCollum, B. B.: Fundamentals Involved in Prescribing Restorative Dental Remedies, D. Items Interest **61**:252, 1939.
2. Eberle, W. R.: A Study of Centric Relation as Recorded in a Supine Rest Position, J.A.D.A. **42**:18, 1951.
3. Higley, L. B.: Some Controversies over the Temporo-Mandibular Joint, J.A.D.A. **27**:597, 1940.
4. Sicher, H.: Oral Anatomy, St. Louis, 1949, The C. V. Mosby Co., p. 162.
5. Sicher, H.: Ibid., p. 164.

25 E. Washington Street
Chicago 2, Ill.

THE CASE OF THE RETRUSIVE MANDIBLE

V. S. Boddicker, D.D.S.

Phoenix, Ariz.

"STEER clear," you are told by many clinicians, "of the patient who brings to your office an assortment of dentures he cannot wear." Now let's be honest. Would you wear any of those dentures yourself if you had that patient's mouth? If you make a thorough examination before answering, I believe you will agree that in most cases your answer would be "No."

In a large percentage of these problem patients, you will find, "The Case of the Retrusive Mandible." The complaints are many and varied, but prominent on the list of complaints is lack of esthetics. Inaccurate centric and accompanying symptoms are common. Balanced occlusion is rarely found, even though the patient brings forth a seemingly endless supply of dentures. If the occlusion is balanced, it is frequently done at the expense of other considerations. Normal speech has not usually been considered.

The patient always has a true centric (seemingly retrusive) but sometimes has an acquired centric further forward. He often has an abnormally great anteroposterior range of jaw movements, sometimes being nearly an inch.

This type of patient can be induced to bite back into centric position, but during speech and for many normal (for that individual) jaw movements, the mandible is brought forward to such an extent that upper and lower anterior teeth appear to have nearly an end-to-end relationship.

"How then," you may ask, "can this individual with such conditions be properly handled?" Before starting the case, it seems advisable to explain to the patient his peculiarities through the use of office models and the patient's own study models. Discuss also (without getting technical) the method of attempting to solve the problem. In this way, we can expect the utmost in patient cooperation. By this means, we justify our fee for the case and give the patient something to brag about. He is different from the ordinary and is, in his language, "difficult to fit."

Since many phases of the procedure resemble those of any careful denture construction, only variations will be stressed. Developing impressions, casts, and baseplates with wax bite rims are normal procedures. The light "F" sound is the most suitable guide for establishing the length and position of the upper anterior teeth. The upper bite rim is adjusted so that the lower lip lightly contacts the incisal edge on the "F" sound. In this retrusive mandible type of case, it is well to establish the incisal edge as far posteriorly and as high as normal speech will allow. We thereby gain as much space as possible for later setting the anterior teeth, without disregarding other factors.

Received for publication Dec. 29, 1950.

Proper contour of the upper lip is established at this time by adjusting the wax bite rim. To establish vertical dimension we use the rest position of the mandible as the starting point. Even though it is frequently necessary to use a maximum opening to provide enough space for setting the teeth in this type of case, it should not be overdone. With natural teeth, it is quite common for this patient to have 5 to 7 mm. of free-way space.[1] It is for this reason that we allow 3 to 4 mm. free-way space whenever the case affords sufficient vertical dimension for the setting of teeth. Never should there be less than 2 mm. clearance between the upper and lower posterior teeth as the patient pronounces the "S" sound as in Mississippi.

True centric relation is established by using a Gothic arch tracing. This is essential because of the abnormally retrusive mandible. Forward thrusting habits of the patient make it difficult to obtain true centric relation, without a tracing. It is equally important that we observe the habitual centric or forward thrust position. The patient uses these two positions so interchangeably and so naturally that he is unaware of their existence.

The reasons for this can be understood when we consider the fact that the tongue is a part of the lower anatomy of the mouth. The tongue is usually in relatively the same anteroposterior position as the mandible which surrounds it. As the tongue is thrust forward in speech, the retrusive mandible is brought forward to help in the formation of normal speech sounds. A great degree of protrusion is necessary for the incisive bite. Frequently this type of patient has been wearing dentures which do not allow the jaws to be in true centric relationship. These factors all combine to make the forward bite seem like a normal position for that individual at the moment.

Because the patient uses a variety of mandibular positions so naturally, we should allow for them in constructing his dentures. He will be comfortable only if allowed freedom of movement. Locking the occlusion in either true centric or in a protruded position can be equally unsuccessful in this type of case. The use of mechanical form posterior teeth is a must. (I like Hall's inverted cusp teeth.) Only with a flat cusp tooth can we adjust the occlusion for an even contact in both true centric and the forward thrust position. In addition to this even contact, we balance the occlusion for protrusive and lateral bites by one of two methods.

OCCLUSAL BALANCE, FIRST METHOD

The first, and usually the most satisfactory, is a spherical occlusion. This is satisfactory because it gives the same degree of contact and balance for all positions, within the normal chewing and biting range. The sphere is adjusted according to condylar readings, a smaller radius sphere being used in cases with steep condylar paths. The upper anterior teeth are set according to the established bite rim. They form the anterior portion of the segment of a sphere. The incisal guide is set with a negative or reverse inclination which allows the upper jaw member of the articulator to move downward in

the front and up in the back for the protrusive movement. The lower front teeth are set to the labial incline of the lower ridge but not anterior to it. They are adjusted for the incisive bite. Their incisal edges are actually at a lower level than the incisal edges of the upper anteriors. The upper first bicuspids are adjusted by grinding. We flatten the occlusal surface somewhat and make the occlusobuccal angle obtuse. This allows a continuation of the spherical arrangement and a normal straight up-and-down inclination of the bicuspids for normal appearance. The other posterior teeth need only slight adjustment to correct irregularities of the occlusal surfaces. The remaining bicuspids and molars are set so the occlusal surfaces complete the segment of a sphere. All posterior teeth must be kept in well over the ridge to prevent dislodging forces. This can be overdone, so tongue space, normal speech, and esthetics should also be considered.

When a case presents a limited amount of vertical space, or where the esthetics prevent the use of the spherical setup of anterior teeth, a modified spherical setup is used. In many of these cases, the necessity for modification can be avoided by the use of plastic anterior teeth which can be reduced at the ridge lap. The same modification is also used in cases where the posterior part of the lower ridge ascends so rapidly that it is inadvisable to use a normal second molar occlusion.[2]

OCCLUSAL BALANCE, SECOND METHOD

In this arrangement, the upper teeth are set to a sphere just as in the first method, except that the second molars are not included at this time. Lower bicuspids and first molars are set and adjusted for excursive movements just as in the regular spherical setup. At this time the incisal guide, which has been negative, is set to a flat or positive inclination, the amount of inclination being dictated by the available space for anterior teeth, and by esthetic requirements. It is advisable to keep the incisal guide inclination to a minimum, so that a smooth glide can be developed later, in moving from the spherical portion of the occlusal excursion to the more anterior or incisive phase. The lower anterior teeth are set for incisive bite.

The upper and lower second molars are set. They are so spaced and inclined that the protrusive movement brings the second molars into contact at the same time the incising bite is reached in the anterior region. Protrusive balance is thereby developed without interfering with the even contact in any of the less exaggerated movements. The final adjustments are made without the use of the incisal guide pin.

It is most gratifying to see how natural the same teeth appear in the mouth as the patient goes through his natural movements, after seeing the completed setup on the articulator with the extreme retrusion of the lower cast. In most cases, the fact that the lower anteriors are fairly short is not apparent. In some instances the lower anterior teeth are as much as one-half inch or more to the lingual of the upper anteriors (in true centric). Usually this is

not noticeable because speech and other natural movements (other than actual chewing) bring the lower jaw forward, making the lower teeth appear to be in normal position. The patient will not comment on the extreme retrusion of the lower teeth unless he is told to look at his teeth while they are closed in centric occlusion, something that he will not do except in the dental office. The advance explanation will have the patient prepared for this type of peculiarity, and he is not likely to be unreasonable in his demands.

Anterior teeth can be shifted to look somewhat irregular if the esthetics demand, but we must use care to avoid disturbing incisal contact during excursive movements of the mandible. The waxed trial dentures are checked for all mechanical phases, as well as speech and esthetics. Corrections, if needed, are made.

The laboratory steps necessary to complete the case are ordinary. With a well-contoured gingival anatomy and stippled finish (cases of this type sometimes show gingival base material), the patient will be pleased with the esthetics as well as the comfort and efficiency of his dentures. Handling the case of the retrusive mandible can, in this way, be a satisfying experience.

REFERENCES

1. Thompson, John R.: The Rest Position of the Mandible and Its Application to Analysis and Correction of Malocclusion, Angle Orthodont. **19**:162-187, 1949.
2. Sears, Victor H.: The Need for Basic Principles in Denture Construction, J.A.D.A. **41**:536-540, 1950.

526 E. Roosevelt
Phoenix, Ariz.

SPECIALIZED FRICTIONAL ATTACHMENTS AND THEIR ROLE IN PARTIAL DENTURE CONSTRUCTION

WILFRID HALL TERRELL, D.D.S.

Pasadena, Calif.

THE use of precision attachments for partial denture retention is a practice builder for the better class of dentistry and helps to elevate the general standard of partial denture prosthetics. This work is not given with the idea of discrediting the usual type of partial denture work, which, of necessity, must be used principally because of economic reasons. But it is presented with a feeling that it is the finest that can be given in partial denture construction. It may serve as an inspiration for a gradual improvement in the type of work that is done; and knowledge of this work makes it possible to apply it in many cases where it could be used, and in this way it gradually creates or builds a demand for this better type of service. You do not have to be a super dentist to do this type of work, but it does require extreme accuracy and should not be attempted by anyone who does not like detail. The average dentist in the United States does not do precision attachment work, but there are many of the finer practices throughout out the country that employ this technique, and it is in demand by that class of patients who can afford it.

I am not going into the history and development of this, but, like all other techniques, many men have added their contributions to its refinement. I think probably Herman Chayes of New York and B. B. McCollum of Los Angeles deserve the greatest credit in the developing of precision attachments. An entire paper could be written on its history and development, but instead, I am going to give the details of the technique as we do it in our own office. I am sure that some can make practical use of this, and others may as time goes on.

PRECISION ATTACHMENTS

Before going into the technique, I will explain just what the difference is between these and other types of partial dentures. The retention is obtained by means of specialized frictional attachments known as precision attachments. Different ones are called by the name of the man who developed them. These attachments consist of two parts, a male and a female part. The male part is that which is shaped like a "T" which is attached to the partial denture. The female portion is the boxing which is soldered into the abutment inlay or crown, and it

Read at the Twelfth Australian Dental Congress at Sidney, Australia, August, 1950.
Reprinted from the Dental Journal of Australia 22:471, 1950.
Received for publication March 22, 1951.

is into this that the male attachment fits. All attachments on a case must be absolutely parallel with the path of insertion of the partial denture and with each other. There are no clasps used as retainers, and these internal attachments serve as frictional retainers and also as rests to carry the load in tooth-borne cases. On tissue-borne cases the McCollum distal extension attachment is used. The retention of this attachment is identical with the others, but the saddle is attached in such a way as to be hinged to the male attachment instead of being soldered rigidly to it. This allows for tissue compression without putting a distal strain or pull on the abutment teeth. This same principle can be applied to clasps, and later a technique will be described for the construction of clasps which have the identical action in eliminating the stress, which the distal extensions do in a precision attachment case.

Since there are no clasps, and since the case is retained by internal attachments, it is evident that each abutment tooth must be prepared and have an inlay or a crown in which the attachment is placed. Very seldom is it necessary to prepare a perfectly good tooth in order to place an attachment, for usually when a patient has lost a number of teeth and requires a partial denture there will already be restorations in many of the other teeth. However, when you construct a fixed bridge you do not hesitate to make a preparation on the abutment tooth to carry that fixed bridge. For the same reason, when a case of this type is to be constructed you should not hesitate to prepare the abutments any more than you would to prepare the abutments for a fixed bridge. A good restoration is not a detriment to a good tooth, but actually serves as a protection to the surfaces which are covered. With present-day techniques it is possible to construct inlays and three-quarter crowns which fit so accurately that we need not worry about recurrent caries around the margins. There has been the criticism of this work that it requires deep preparations in order to allow for the attachments. This criticism shows lack of understanding and lack of practical application in practice. These cavities need not be cut any deeper than the average preparation in order to house the attachments. However, it does require skill in paralleling the preparations so that the attachments may be placed to the best advantage. You will always find criticism by those who do not understand the principle too well, or who have not employed it successfully in their practices. The proof is in the practical cases, and I invite any of you who can to spend some time with me and see numbers of these cases that have been functioning for many years and with the greatest satisfaction.

I have heard some men state that they never construct a clasp case, but that they do 100 per cent attachment work in their offices. I do not agree with them, for I think both clasps and attachments should be used, and I feel we should apply them when and where they are indicated. That is like a periodontist saying that he treats all periodontia with surgery, or by electro-coagulation, or by instrumentation only. The intelligent man will employ all methods at his command and apply them where they should be used. We should keep our feet on the ground

and not go overboard for one technique or another to the exclusion of all others, any more than a physician should apply the same remedy to every patient with the same disease, regardless of his general physical conditions and complications. I do hope some of you who have never attempted precision attachment cases will try them, and I hope those of you who have made a few will find it easier to make many more of them. There is a great satisfaction both to yourself and to your patients in the completion of work that you feel is the finest that could be made.

Some of the advantages of precision attachment cases are as follows:

1. The attachments are parallel to each other so there is no strain on the abutment teeth in placing and removing the appliances.

2. There are no clasps under which caries, abrasion, or erosion can develop.

3. The abutment teeth help support each other as they are tied together by these parallel attachments.

4. Esthetics is much improved because of the elimination of unsightly clasps.

5. They are more pleasant to wear as the design can be much more simple and places for food lodgement can be eliminated.

6. The strain on the abutment teeth on distal extension cases is relieved by the use of the distal extension attachment.

7. They are easily adjusted to any amount or degree of tightness with no danger of strain on the abutment teeth.

8. They are very easily kept clean because there are no exposed parts except the saddles and connectors.

9. They appeal to the better class of patients and serve as a practice builder because of their advantages.

Since this work is not taught in the dental schools, and since the demand for it is comparatively small, there are few opportunities for the practicing dentist to learn the details of construction. It is not difficult or complicated, but does require painstaking accuracy. Few laboratories or technicians are trained to do this work, but I have had several technicians during my time in practice that I have taught and they have all become very adept at it. Some men have tried making their own attachments and I have seen some of the cases so made. I would not consider them very satisfactory. If you are going to do precision work it should be precision. The manufactured attachments are extremely accurate and surpass anything you can make in your own laboratory. They are well worth the price you pay for them. The actual cost of the complete attachment is less than you would charge your patient for a gold inlay and you could not afford to spend the time to try and duplicate these. The fees you get for these cases well cover the additional expense. The attachments are made from high grade platinum alloy. They will withstand a great deal of wear, and will hold their adjustment.

TECHNIQUE

The technique, as I first learned it, has been much improved and simplified, and it is much easier to make one of these now than it was then. The use of the hydrocolloid technique for the impression of both the abutment teeth and the appliance has given us greater accuracy and more ease of construction.

Before starting the case, study casts should always be made and a plan of construction laid out on the casts. The outline of the partial denture should be drawn, and the teeth to be used as abutments should be surveyed on a surveying instrument to determine the path of insertion and the position and form of the preparations which are to be made in the abutment teeth (Fig. 1). The preparation of individual abutments with no thought given to the paralleling of the axial walls invites failure. All partial denture work should receive careful planning, but it is impossible to do precision attachment work without first making a study of the case.

ABUTMENT PREPARATIONS

The next step is the preparation of the abutments. Operative as well as prosthetic dentistry has made valuable improvements in the last few years. The time required in cavity preparation has been greatly reduced, and the accuracy with which we can make our castings is not to be compared with techniques used before the advent of the hydrocolloid technique. I do not use a rubber dam for the preparation of the cavities in the abutment teeth. The preparation can be done in much less time and with less shock to the tooth if it is done under water. At the present time I am using carbide burs and diamond stones almost exclusively, and I can prepare cavities by this method in one-fourth to one-half the time it took me using the rubber dam, and cutting the tooth dry with the ordinary dental burs. I use an attachment on the handpiece which throws a fine spray on the bur or diamond stone when it is cutting. This keeps it clean, makes it cut much faster, and eliminates the danger of overheating the tooth. This same result can be obtained by having the assistant keep a constant spray on the bur or diamond as it is cutting. Definite box forms should be prepared in the abutment teeth, and these should be parallel and a little wider than the attachments. The attachments come in various sizes and it is best to select the widest attachment which can be used in the space and still have some room for paralleling. All abutment teeth are prepared before any impressions are taken. Mesio-occluso-distal inlays, three-quarter crowns, or full crowns are the usual preparations that are used.

IMPRESSIONS

When the preparations are complete we are then ready to take the impressions. It is necessary that the gum tissue be clear of all gingival margins. For this purpose we use either 50 per cent zinc chloride or the electric cautery. The electric cautery is not necessary unless there has been a previous restoration which goes below the gum line or unless there is caries extending beneath the free gingiva. When the gingival margins have all been cleared, the cavities are

dried and hydrocolloid is injected into all the cavaties first, then a full maxillary or mandibular tray which has been previously filled with hydorcolloid is placed in the mouth. In one impression we secure an accurate impression of all the cavities in the abutment teeth, of all other teeth in the arch, and the edentulous areas which are to be restored. A water jacketed tray should be used, and the hydrocolloid should be thoroughly chilled with ice water for at least five minutes. Removing an impression too soon is the usual cause of errors or remakes. There is no place for any inaccuracy in this technique. The individual abutment teeth are then poured in a very hard stone and a metal tapered pin placed in each while the

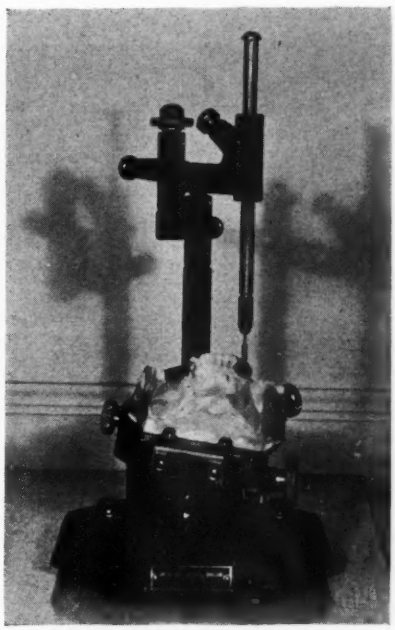


Fig. 1.—A precision surveying instrument.

stone is still soft. When these are thoroughly set they are removed, trimmed, and placed in mineral oil to harden. The entire impression is then poured after these individual dies have been removed from the impression. The abutment teeth are not made removable in this cast for reasons of accuracy. After the impression is poured it is placed in water to set. When the stone has set the master cast is removed, the inlay dies are coated with petroleum jelly and placed in the impression, and a second cast poured which will give us a working cast with removable dies in which the inlays or three-quarter crowns or full crowns may be carved to contact and occlusion.

The box form for the attachments is carved in the wax-up of the abutments so that they are all parallel. This can best be done by placing the cast on a clasp surveyor and using the vertical arm of the instrument as a paralleling device (see Fig. 2). Tilt the cast so the path of insertion is vertical, and then carve the box

forms in the wax patterns of each abutment parallel to this, and they will all be parallel to each other. We use the vertical arm of the clasp surveyor as a parallelameter. A chuck is attached to it which holds the mandrel on which we place the female attachment when paralleling the carvings in the wax. The boxings in the wax patterns are carved to accommodate the attachments. Thus, when all the abutment castings have been made and assembled on the master cast, we will find that the attachments can easily be paralleled and all abutment castings will be properly contoured to house the attachments. I think you can see why it would be impossible to construct individual inlays or three-quarter crowns and expect to be able to place attachments in these that would be parallel.

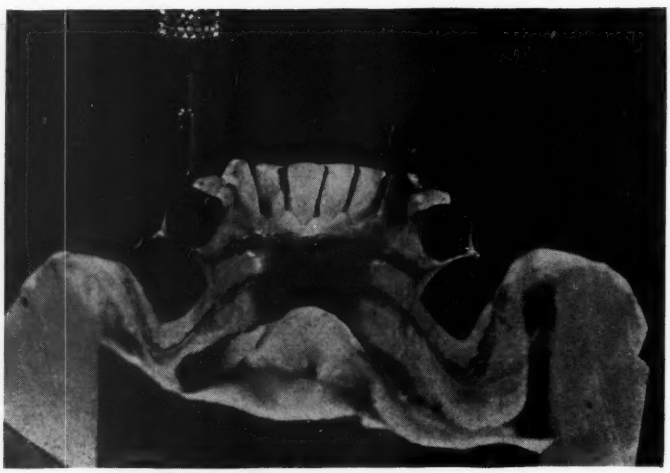


Fig. 2.—Surveying for precision attachments.

ASSEMBLY

The next step is to parallel and solder the female attachments in each of the abutment castings. This is not difficult, as they are held in place with sticky wax. Then the inlays, with the attachments, are removed from the cast and are imbedded in soldering investment. Thin, flat carbons are provided which fit loosely in the female attachments. Soft investment is worked into the attachment with this carbon point. The investment is then placed around the extending portion of the carbon and around the inlay or crown leaving the front open for placing the solder. When set, the wax is removed with hot water, and the investment is thoroughly dried in the oven. The carbon point which was placed in the attachment and in the investment holds the attachment in its proper relationship to the inlay while solder is flowed around it. Always be sure to paint all parts where solder is not to flow with a solution of chloroform and rouge. It is well to solder one attachment first and replace it on the master cast, check it with the mandrel, and then parallel the others to this first one which has been soldered. The paralleling of the attachments should be done on the master cast and not on the

cast on which the inlays were carved, as removable dies may produce a slight error which would not happen on the rigid cast.

When all attachments have been soldered and placed on the cast and checked, we are then ready to prepare for making the duplicate cast in investment on which will be cast the partial denture. All undercuts around the abutment teeth are eliminated with undercut wax. The inlays and crowns are removed from the abutment teeth before the cast is duplicated. With a small hydrocolloid syringe, the preparations are filled with hydrocolloid, before the hydrocolloid is poured over the master cast. This is done in a duplicating flask and is thoroughly chilled. The cast is removed from the hydrocolloid (see Fig. 3). The mold is poured in a refractory investment. If it is to be an upper partial, we always scrape the master cast along the palatal border of the partial denture outline before

Fig. 3.—Cast duplication.

duplicating. This edge of the partial will fit tightly against the tissues, and prevent food from getting under it, and and the patient's tongue from feeling the edge. When the investment cast has been thoroughly dried it is boiled in beeswax in order to harden it, and prevent if from flasking off while working. There is also cast spray which works very well for this purpose.

We used to make these cases entirely with gold bases and tube teeth. However, since the advent of acrylic base materials we are now making them with the framework of gold, and the saddles are made of acrylic for esthetic reasons. Also so they can be rebased when necessary.

At the next appointment we fit the abutment castings in the mouth, adjust the occlusion and contacts, and polish.

The inlays and crowns with the male attachments placed in them are now put on their respective abutments on the investment cast (see Fig. 4). A forked truss is waxed around the extension of the male attachment to which it will be soldered later. When the partial denture casting is made it is placed back on the

master cast as are the abutment castings with the complete attachments in them. A plaster core is made relating each of the male attachments to the partial denture casting. These are removed and after anti-fluxing where necessary with chloroform and rouge, are invested and the male attachments soldered to the partial denture casting. If a distal extension attachment is used we cast a gold tooth around the distal extension having previously soldered a tube to the side of the housing and drilled and tapped it for the screw (see Fig. 5). After this has been cast, it

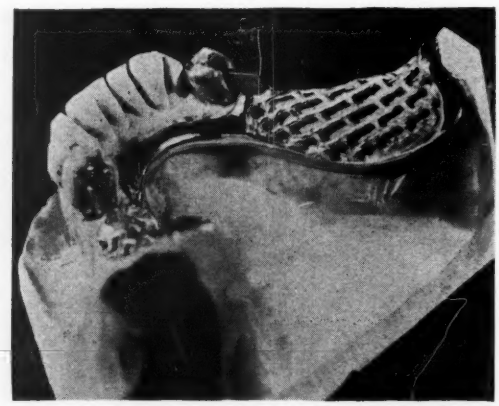


Fig. 4.—Distal extension attachment in place.

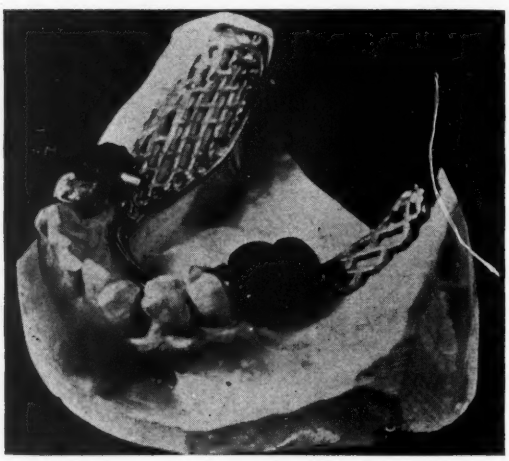


Fig. 5.—Distal extension attachments in place with wax teeth carved.

is assembled on the master cast, a plaster core is made, and it is invested and soldered to the partial denture casting. It is possible in some cases to use plastic teeth in this position, but we usually prefer to cast them in gold with porcelain or plastic facings.

Wax occlusion rims are built on the metal framework, and at the next appointment we check the framework and the parallelism of the attachments in

the mouth. If there should be any discrepancies in the parallelism or if any error has crept in, it will show up at this time and can be corrected before the case is completed. Check-bites are taken with a central-bearing device and plaster if it is a bilateral distal extension case or in wax if it is tooth borne.

The casts are then mounted on the articulator and the teeth set up. If we are making a partial denture in only one arch then we take an alginate impression of the opposing arch, and pour a cast in low fusing metal. The teeth are articulated against this metal cast. When the teeth have been set up, we have an appointment with the patient for a final check and the case is then cured and finished for delivery (see Fig. 6).

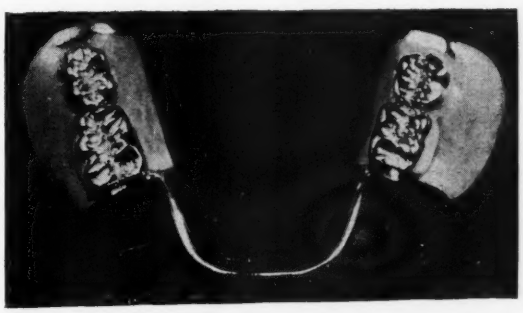


Fig. 6.—Closebite case with all gold occlusals.

Fig. 7.—A complete mouth reconstruction using distal extension attachments.

CEMENTATION

Ample time should be reserved at the time of cemenation. We usually never allow less than two hours for this appointment. However, we do not make a practice of cementing the abutments on the first day. There should be sufficient frictional retention of the abutment castings to hold the case in place, and we have the patient wear it for at least twenty-four hours before cementation. The patients

are instructed not to remove it themselves. This gives the attachments a chance to loosen up slightly and for all parts of the case to settle into position (see Fig. 7). On the day of cementation we take plenty of time to seat each abutment individually. We thoroughly sterilize the cavities with thymol and follow this with chloroform to remove any of the essential oils. Alcohol is a dehydrant and is unnecessarily painful. The cavity is then coated with Copelite, a thin cavity varnish which penetrates the surface of the dentine and prevents irritation by the cement. Before

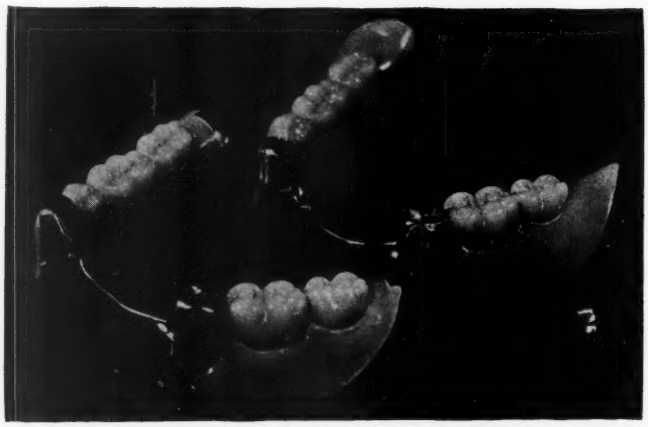


Fig. 8.—Duplicate precision attachment partial dentures.

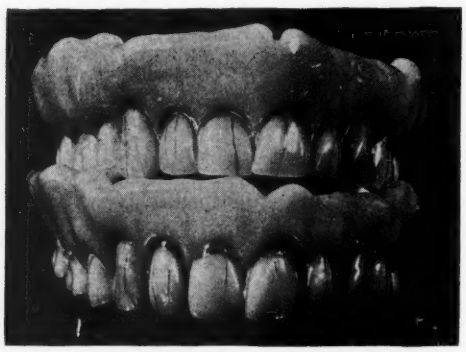


Fig. 9.—Duplicate upper dentures made interchangeable with either precision attachment lower partial denture.

cementation we always remove a very thin layer of gold on the axial wall of the restoration and then serate this surface so that the cement has a mechanical retention. The patient is again instructed not to remove the partial until the next day at which time it is adjusted and the patient is given instructions as to its removal and care. It is well to have them back again the next day for a check-up to see that everything is functioning properly and that they are having no difficulties (see Figs. 8 and 9).

OTHER ATTACHMENTS

There is another type of attachment, called a Dowell Rest Attachment, which does not require the purchase of any manufactured parts. This was developed by Thompson, and there is another called the Spring Lock Attachment which was developed by Neurohr. You may be familiar with these. They both require the preparation of abutment teeth for inlays or crowns. The Dowel Rest Attachment has a small clasp on the lingual which has a ball-point cast to fit in a depression on the lingual of a three-quarter crown. This serves as a retainer, preventing the attachment from coming out of the abutment. The stress is borne by a dowel which is attached to the partial denture and fits into a counter sunk groove on the distal of the crown. The Spring Lock is similar, but it is retained in place

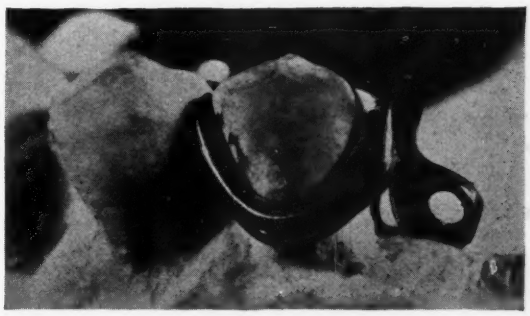


Fig. 10.—The distal extension clasp to which the saddle is hinged.

Fig. 11.—Casting for a stress-breaker case.

by a spring wire which snaps into a notch in the abutment casting. This must be released before the attachment can be removed. Neither of these have the refinement of the precision attachment, but do have some advantages over clasps. They do break the stress on the abutment in distal extensions and do not rest on tooth structure, and there is no display of gold as with clasps. If I were going to prepare a tooth for an abutment casting I would rather go all the way and make a precision attachment case than to use one of the other substitute type which is only a compromise in refinement. However, in cases where it is important that gold not be shown and retention must be secured, some men prefer to use these and save the cost and work of precision attachments.

STRESS BREAKERS

I will now describe a stress breaker which we have developed for use with clasps and which we are using in the office in all distal extension cases retained by clasps. As I said in the beginning, I do not make precision attachment cases for all my patients, and I do feel there is a big place for clasps in partial denture work. One of the greatest causes of loss of abutment teeth in partial dentures has been the clasping rigidly of a long distal extension saddle to an abutment tooth. We have all seen these teeth loosened and lost as a result. However, with the use of this stress breaker it makes it possible to have the same effect as you would have with a distal extension precision attachment.

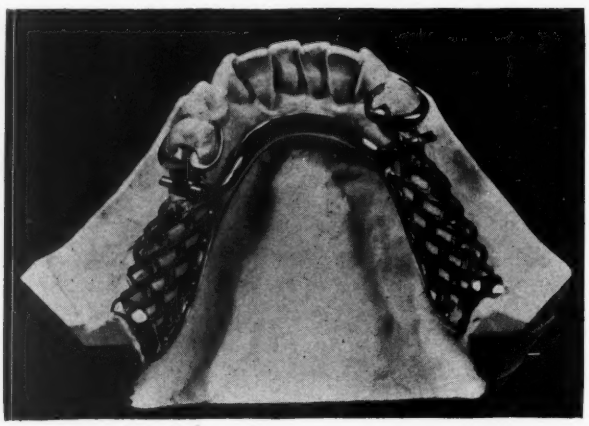


Fig. 12.—Finished casting for broken-stress partial denture.

Before impressions are taken for any clasp case, be sure that adequate preparation has been made for the occlusal rests. A clasp will not hold its position properly without an occlusal rest, and the rest also transmits some vertical force to the tooth and makes the partial denture more efficient and comfortable. Impressions for these cases may be taken either with hydrocolloid or the alginates. The cast is poured in hard stone and surveyed on a clasp surveyor. All undercuts on the abutment teeth are blocked out with undercut wax. The path of insertion is outlined and the height of contour on the abutment teeth marked, first with a clasp surveyor and then with an indelible pencil. The cast is then duplicated in investment material, the duplicating flask is kept wet while the investment is setting, and a second duplicate cast is poured in the mold. The first cast is the one upon which the partial casting will be made, and the second cast is the one on which we wax up and cast the clasps. The clasps are waxed according to the survey lines. In place of the usual truss arm which extends from the body of the clasp to the saddle, we use a piece of pink baseplate wax set edgewise to form this truss and at the bottom as close to the tooth and as close to the ridge as possible a hole is made in the wax thru which will pass a screw that will hold the clasp to the partial and form the hinge which provides the broken stress between the

saddle and the clasp (see Fig. 10). The clasps to which broken stress is to be applied are cast first. When the individual clasps have been cast they are polished and fitted to the master cast and then placed on the other investment cast. The frame work for the partial, including all other clasps, is then waxed up. On the brokenstress clasps we wax a thin flange on either side of the truss extending down from the clasp. It is left open on top and underneath, and is so formed that the saddle can move down at the distal but cannot rise. A hole is made thru the wax to correspond with the hole in the truss. The cast clasps are then removed and the case is invested and cast (see Fig. 11). After that it is cleaned up and fitted to the master cast and fitted also to the clasps. The holes are then enlarged to the size of the screw which is to be used. The screw is placed in the lingual

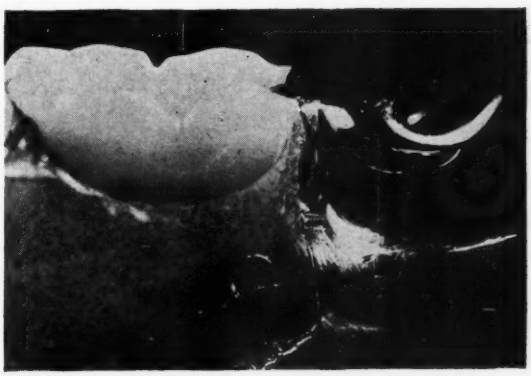


Fig. 13.—Close-up of distal extension clasp.

from the buccal and is threaded only into the lingual plate in which the vertical truss fits. That portion of the screw which passes through the vertical support of the clasp is not threaded and is a snug fit. When this screw is in place the clasp is free to move forward and backward, but when the case is cured it can only move forward. This results in allowing the distal of the saddle to move downward under pressure, but it cannot lift. The truss arm of the clasp fits rigidly in its slot and cannot move sideways, thus giving the abutment tooth lateral support from the other clasped teeth. This stress breaker is very easy to construct. It takes the minimum amount of space and will allow for tooth replacement directly against the clasped tooth even in very short bite cases. It functions exactly as a distal extension attachment on a precision attachment case (see Fig. 12). It relieves the stress on the abutment tooth where we do not wish to cut into these abutment teeth, and gives the patient the most permanent type of restoration that we know. While there are many who disagree with broken stress, we have all seen much damage done where stress breakers were not used where indicated, and we have also seen damage done by the use of the wrong types of broken stress. However, I have not seen damage done by distal extension precision attachments, nor have I seen any harm occuring as a result of the use of this new stress breaker. I am sure that the life of abutment teeth, when freed from a

distal pull, is going to be much longer than it would be if those saddles were attached rigidly to a clasp, which would either spring up and down on the tooth or pull the tooth with the saddle (see Fig. 13).

I hope these explanations have not seemed too complicated and that after using some of these attachments you will find much satisfaction in their continued use. If we give our patients the best that we know at all times, and continue to improve and progress as we have the opportunity, it will pay dividends both in satisfaction from our work and from the type of practice we build. If we will do our work better than average even if it costs more to do it both in time and overhead, it will pay dividends in the long run.

News and Notes

ANNOUNCEMENT

The Pacific Coast Society of Prosthodontists will hold its annual meeting in the Bellingham Hotel, Bellingham, Washington, June 21 to 23, 1951.